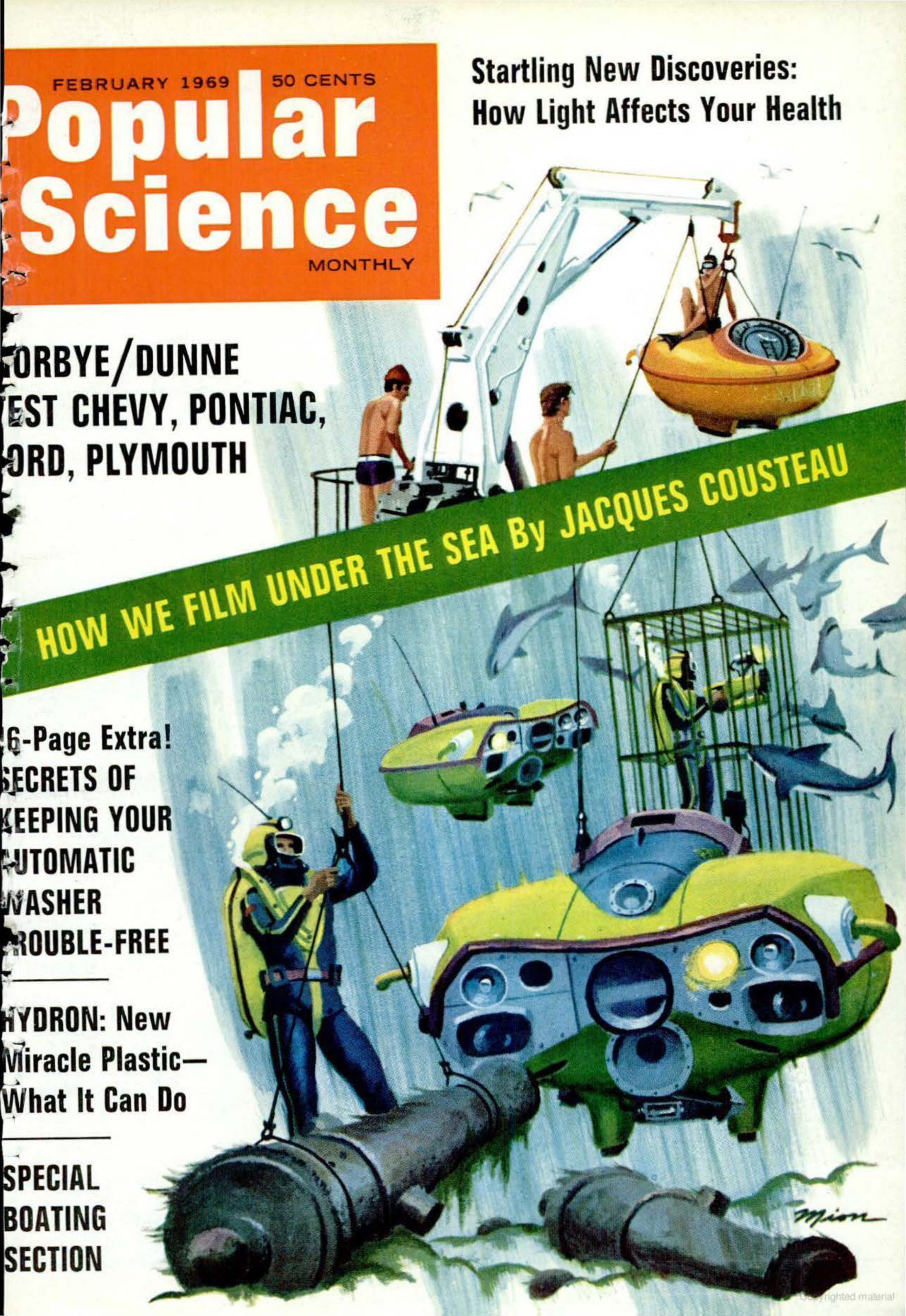
FEBRUARY 1969 50 CENTS

Popular Science

MONTHLY

Startling New Discoveries: How Light Affects Your Health



ORBYE/DUNNE
EST CHEVY, PONTIAC, ORD, PLYMOUTH

HOW WE FILM UNDER THE SEA By JACQUES COUSTEAU

6-Page Extra! SECRETS OF KEEPING YOUR AUTOMATIC WASHER TROUBLE-FREE

HYDRON: New Miracle Plastic— What It Can Do

SPECIAL BOATING SECTION

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When your fish runs, your Chrysler stays clear

Chrysler Lo-Profiles are perfect fishing companions—and there are eight to choose from. OBC-rated at 5, 7 and 9.9 hp.—all designed to sit low on the transom for over-the-stern fishing. They're completely portable, too. Below, you can see Chrysler's Depth-Minder Drive in action—just tilt the prop up and run in as little as 6 inches of water. Weedless leg design prevents snags. As for power, there's our 9.9 pulling an adult skier. And the 9.9 Autolectric, with key-switch starting, even has a dome light for night fishing.

Let a Lo-Profile take *you* fishing. For the name of your nearest Chrysler Crew outboard dealer, call 800-243-1890. It's free. (In Connecticut, call collect: 325-4336.)

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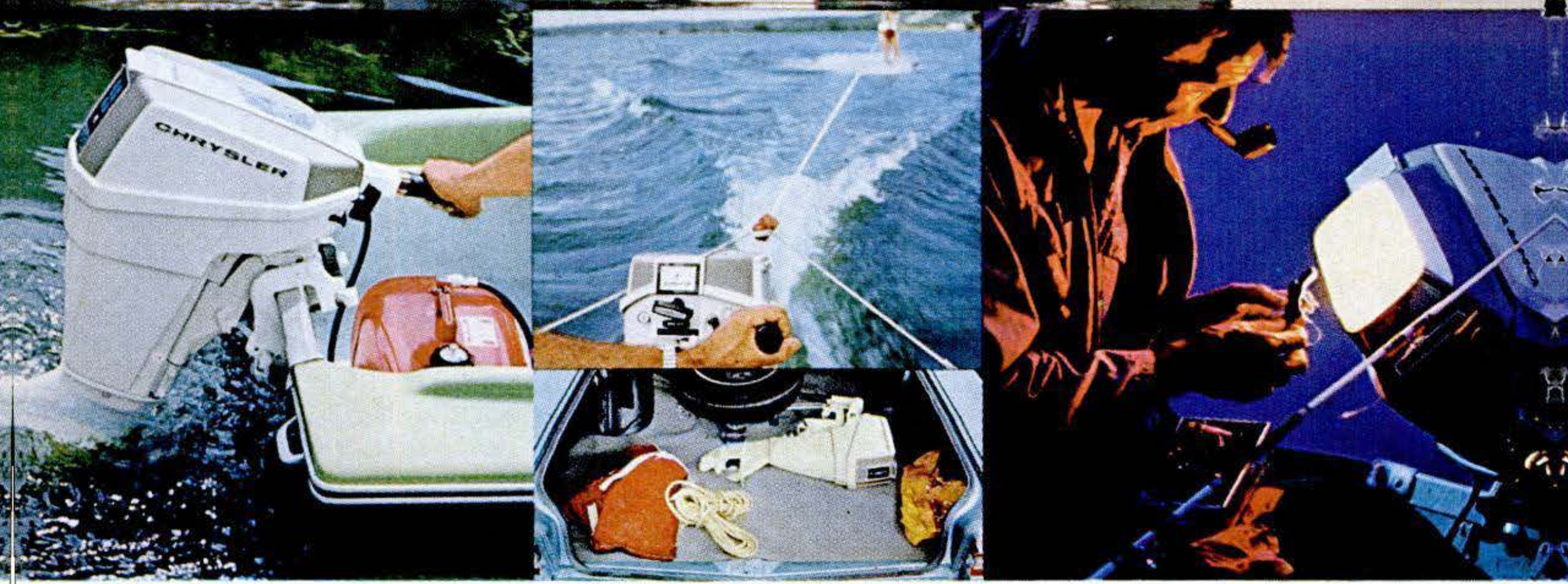

Better boating begins with **CHRYSLER**

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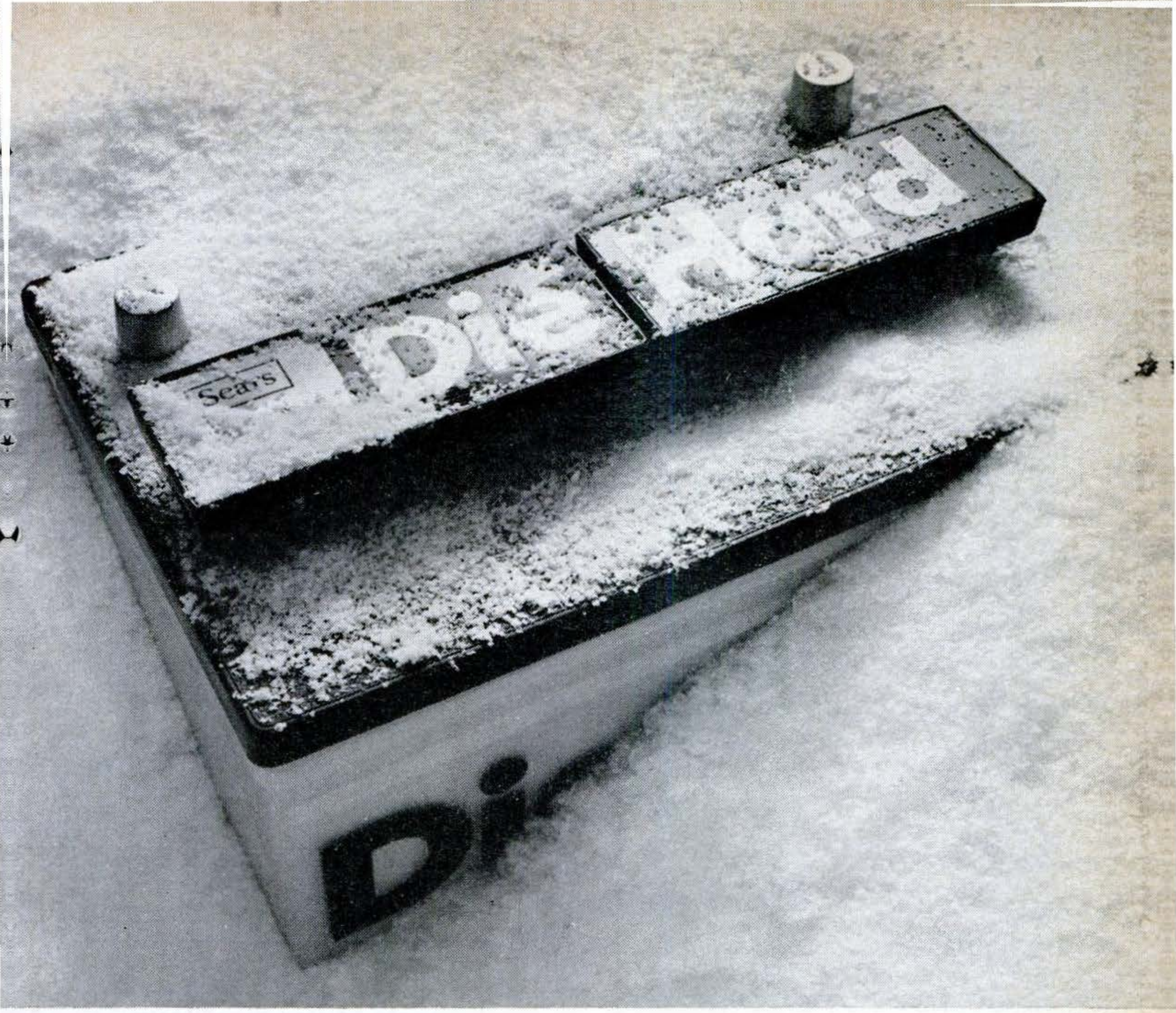

The DieHard won't get you away from it all, but it'll get you started

Size for size, it's America's most powerful car battery—by 35%.

Lying on a sun-drenched beach would be nice. But, at freezing temperatures in a blizzard, it's amazing what you'll settle for. Like getting to the drugstore or getting to work, or just getting home.

The DieHard was invented for just such swell times. It's got 35% more usable starting power than any other battery around.

Polypropylene made that possible. That's the name of the thin plastic case of the DieHard. This case is the same size on the outside but roomier on the inside. For bigger plates and more acid. You couldn't have squeezed all this extra power into a rubber case, and yet this battery case is 6 times stronger than those used for conventional batteries.

If you just have to put up with bad winters, the DieHard will make good company. It's guaranteed for five long years. That's probably longer than you'll keep your car. So why wait? And remember, when Sears guarantees . . . Sears guarantees.

There are over 2500 places to buy the DieHard. They're all Sears, Roebuck and Co. stores. You can Charge It of course on your Sears Revolving Charge.

So maybe the DieHard can't get you to a warmer climate, but if it gets you to work on time, you can bask in the warmth of your boss's smile.

The Sears 5-year guarantee: "Free replacement within 90 days of purchase if battery proves defective. After 90 days we replace the battery, if defective and charge you only for the period of ownership, based on the regular price less trade-in at the time of return, prorated over number of months of guarantee."

The DieHard. Sold only at Sears. $29.95 with trade-in. In Canada, at Simpsons-Sears at slightly higher prices.

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DieHard batteries now fit 97% of the cars on the road. Sears carries a complete line of other fine batteries as well, in a wide range of prices.

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FEBRUARY 1969 Founded in 1872/Vol. 194 No. 2

HIGHLIGHTS OF THIS ISSUE:

How We Film Under the Sea BY JACQUES COUSTEAU PAGE 65

The famous underwater explorer and movie maker tells about his "Sea Fleas," amazing one-man subs that prowl the depths to put the marine world on film. With color photos.

Full-Size Family Cars: Biggest Bargain for Your Buck? PAGE 70

Norbye and Dunne test Chevy, Ford, Plymouth, Pontiac—and pick the two they like best.

Light and Your Health PAGE 78

Throw away your sunglasses? Maybe. Scientists reveal some startling new discoveries.

Hydron: New Miracle Plastic with a Myriad of Uses PAGE 92

Anything's possible: parts for the body, nonfogging glasses, chewing gum—you name it.

Special 18-Page Boating Section PAGE 102

Lots to see and read: picture gallery of boats in color, plus "What's New in Boating" and two great articles—"How to Survive in Rough Water" and "Fuel for Your Outboard."

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COMING NEXT MONTH

Stop! Don't miss the 16-page Special in March—**Brakes for Your Car.** This big PS Extra tells you how your brakes work . . . how disk and drum brakes differ . . . how to use your brakes for safer stops . . . how to check your brakes . . . what causes brake fade . . . how to know when you should reline (and how to do the job yourself) . . . which are the best linings for your car . . . how to break in new linings . . . how much should a good brake job cost? . . . and more.

In the same issue:

- EVR (Electronic Video Recording)—now you can show canned movies on your TV set
- How I Learned to Fly Without Leaving the Ground
- Fun Cars—all about the growing rage for on-and-off-the-road dune buggies
- How to Add Shelves All Through Your House
- PS Takes You Window-Shopping in Russia
- Midship-Engine Matra 530—car design of the future?
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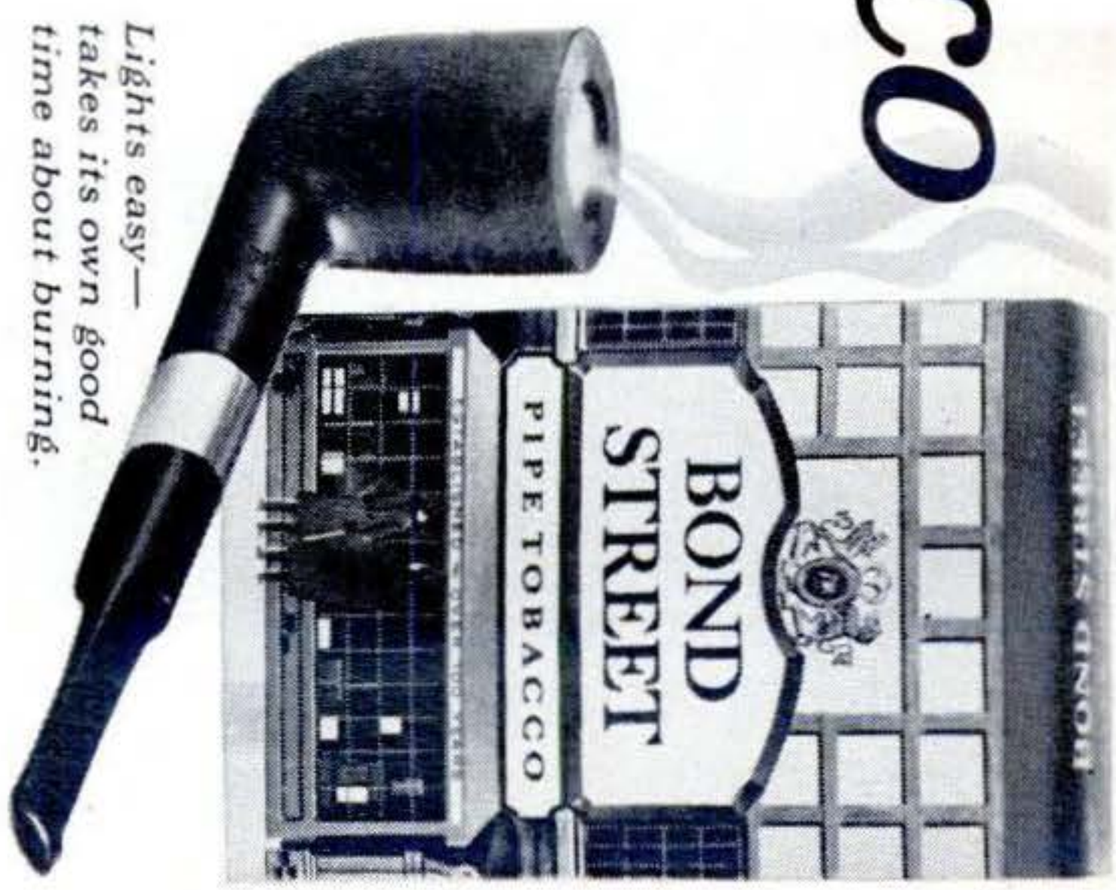
The LazyPipe Tobacco

Don't ever try to rush through a pipeful of Bond Street. It can't be done. Because this rich-tasting combination of plugs and flakes is specially blended to burn slow and even. You can do a good deal of sightseeing in a strange city while a single pipeful is burning its slow and lazy way to the bottom of the bowl. You'll enjoy the gentle taste of Bond Street (and chances are quite good that a passing cab driver or two will have a complimentary word for its incomparable aroma).



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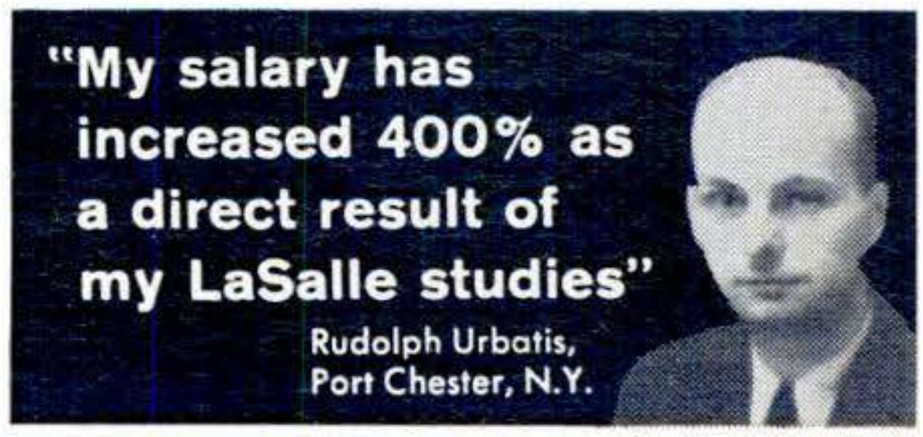

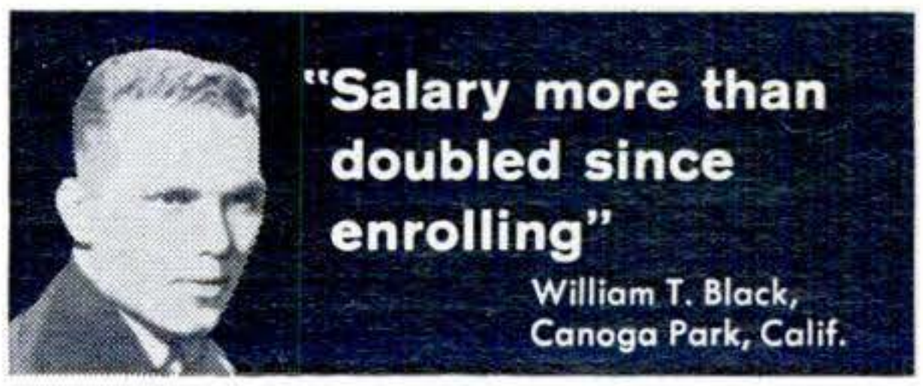

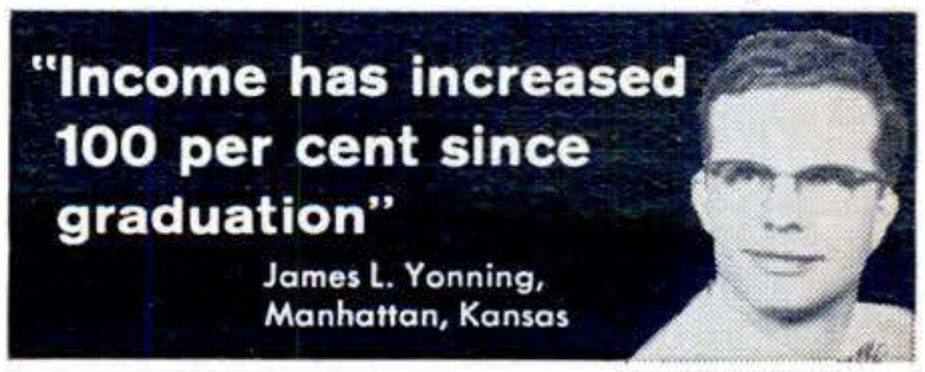

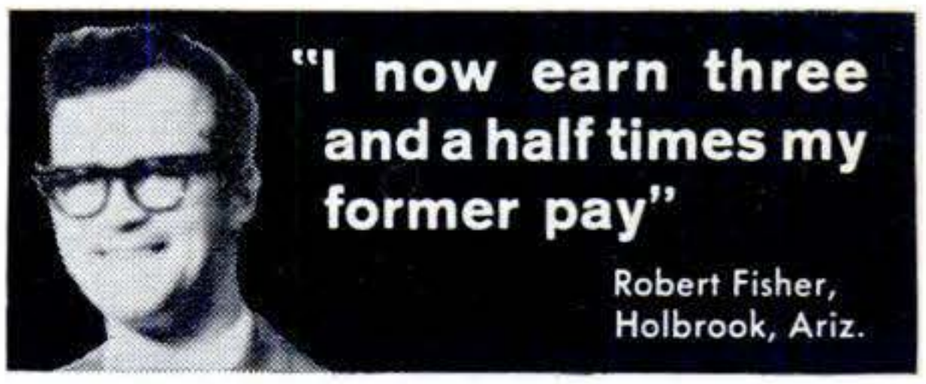

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PS Readers Talk Back

Praise from an air-cooled man

"Antifreeze for Your Car" [Nov. '68] was the best and most comprehensive article on the subject I've ever read. Congratulations. It is also the best argument in favor of an

air-cooled car. I own both kinds and shall never cease to be grateful that at least one does without radiator hoses, water pump, antifreeze, and their attendant troubles, potential and actual.

HOWARD G. RUSSELL, Butler, N. J.

What causes homes to dry out

In "Air Too Dry? Humidify!" [Dec. '68] you say that the woes of dry air apply especially to homes that are heated by baking the air and that if you heat with circulating hot water or steam, you may not even need humidification.

Air heated by any means will expand in volume and consequently be able to hold more water vapor. The need for humidification in our homes is caused by the fact that the air is constantly being changed while being heated from the outside temperature to the inside temperature. If we are to maintain a satisfactory degree of humidity, water vapor must be added.

F. NORMAN HILLIS, Timonium, Md.

Smokey vs. the computer

I enjoyed "Smokey Matches Wits with a Computerized Car Clinic" [Dec. '68]. But the picture of Smokey in front of the "IBM computer's memory bank" actually shows an IBM card reader.

DAVE AMUNDSON, Rochester, Minn.

. . . The article leaves more unsaid than resolved. The areas of disagreement between Smokey's diagnosis and that of the computerized center are in vital and expensive areas: compression, starter, carburetor, steering, axle, and transmission. Either Smokey or the diagnostic center is way off. A third party, perhaps the Ford factory or Cornell's Aeronautical Research Labs, should have made a complete diagnosis to determine who is right and who should have been discredited. How else can we know whether diagnostic centers have limited value to the concerned and more times than not harassed and overcharged motorist?

MATTHEW SCHWARTZ, Flushing, N.Y.

. . . Will Devon Francis show me his *1966* Camaro that Smokey checked?

RAYMOND MYERS, Easley, S.C.

Devon's face is red. He owns a '67, purchased in 1966, of course.

How to keep batteries new in antique cars

"The Battery for Your Car" [Oct. '68] was a thorough job and added importantly to an important part of the auto. But I have a special problem—storing antique cars for six months at a time in an unheated garage. The batteries don't last long this way. What would be the best procedure to prolong battery life?

H. CHARLES RIKER, Huntington, N.Y.

The secret of long battery life is to keep it fully charged. Buy a trickle charger and hydrometer. Bring the batteries up to a fully charged condition at least once a week. Disconnect the ground cable as a precaution against high-resistance leaks in the car's electrical system. Add water to the cells when needed.

Getting the right angle on Japanese

The photo showing Japanese ideograms in "Modern Decoration for Your Wall" [Dec. '68] contains the symbol for winter, but it has been tilted 45 degrees to the right and should look as shown above.

SANFORD K. OKITA, W. Lafayette, Ind.

Expert winter driving

One of the things you recommend in "How You Can Be an Expert Winter Driver" [Dec. '68] is a limited-slip differential. I wanted to order one with my last car for better traction in snow. Salesmen at three different auto agencies convinced me not to buy a car with limited-slip differential. I was told it was only needed by contractors who drive in mud; that it was dangerous under slippery conditions; that they were only for kids who drag race. I was also told that the limited-slip makes rear tires wear out faster because the inside tire

Continued

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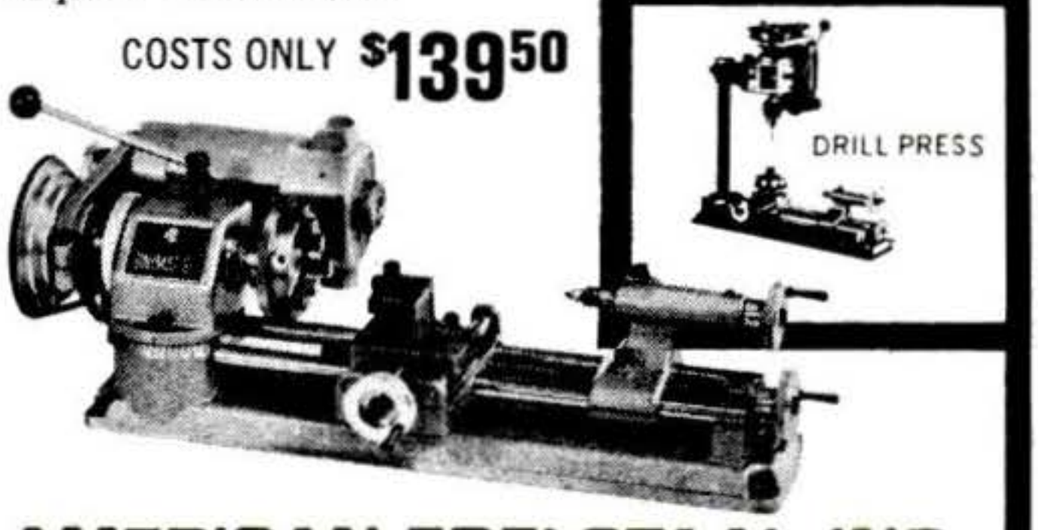

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PS Readers Talk Back
[*Continued*]

would try to turn as fast as the outside tire when the car is cornering. That's why I'm surprised you recommend it.

W. G. BENKELMAN, Lakewood, Ohio.

Early versions of limited-slip differentials were prone to make strange noises on turns at low speeds. They caused car dealers a lot of headaches with customer complaints and warranty service. For that reason, many salesmen were instructed to discourage customers from ordering them. This minor problem has been licked and the arguments the salesmen gave you are nonsense.

. . . I have studded tires on my rear wheels and tried to have a garage fit a pair on my front wheels. I was told this is illegal in my state on two-wheel-drive vehicles. Other garages told me front-studded tires

would ruin my front-end alignment, and that the front wheels could not be properly balanced. I was also told studded tires could not take steering stresses.

J. R. WOODRUFF, Chester Springs, Pa.

Studded tires are not illegal on front wheels in Pennsylvania. Hitting things, not studded tires, would ruin front-end alignment in less than 200 miles. Studs are positioned in a symmetrical and congruous pattern which does not affect wheel balancing. A tire that can take steering loads on dry concrete will also be able to handle them with studs on any surface.

Bearing down on PS

I'm puzzled by the statement on bearing adjustment in "How to Keep Trouble Out of Your Wheel Bearings" [Nov. '68]: "While rotating the wheel, tighten the adjustment nut until all play is about right." I question whether the average person would know what "about right" means. A very simple and foolproof method of bearing adjustment is used on manufacturers' assembly lines and does not require the use of an indicator to check results:

Take up on the adjustment nut while rotating the wheel until the bearings are hard

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to turn—indicating that all parts are seated. Back off the adjustment nut until completely free—do not touch or turn the hub. Then tighten the nut as much as possible with your fingers. Lock the adjustment nut in place without additional back-off.

If threads and bearing fits are within tolerance, the above procedure should provide about .002-inch to .003-inch end play, which is considered ideal.

BOB WILLIAMS, Chief Engineer
Automotive Division
The Timken Roller Bearing Co.
Canton, Ohio

. . . The instructions for wheel-bearing adjustment are quite inadequate for cars equipped with disk brakes. At least where Bendix disks are in use, no play in the wheel bearings is tolerable—unless a brake pedal which is effective at varying heights is acceptable. Any lost motion in the wheel bearings causes the brake pads to be displaced from contact with the disks. This in turn causes considerable change in the effective locations of pedal pressure.

U. S. JAMES JR., Elizabeth, N. J.

We misplace a Canadian ATV

Your Picture News item in the Nov. '68 issue about a "French" amphibious vehicle called the "Castor" is mistaken. It is actually manufactured in Canada. The machine is on loan to the Canadian government and is being shown on a tour of French sports shows. Our company, which manufactures the vehicle, calls it the Beaver. The French word for beaver is castor.

M. FRIEDRICHS, Wheeler Mobile Ltd.
Keswick, Ont.

We regret the blooper, which resulted from a translation error.

How high the price of flying?

The McCulloch two-man autogyro [Picture News, Dec. '68] at $16,000 is not "about half that of the cheapest chopper on the market." It may be the cheapest two-man gyroplane, but the single-place Bensen gyroplane is much lower priced. Although there are many differences, both are choppers and the big appeal of the Bensen is that it brings copter flying within reach of average people.

JOHN B. MAYO, Raleigh, N. C.

Want to get something off your chest? Write "Readers Talk Back," POPULAR SCIENCE, 355 Lexington Ave., New York, N.Y. 10017.

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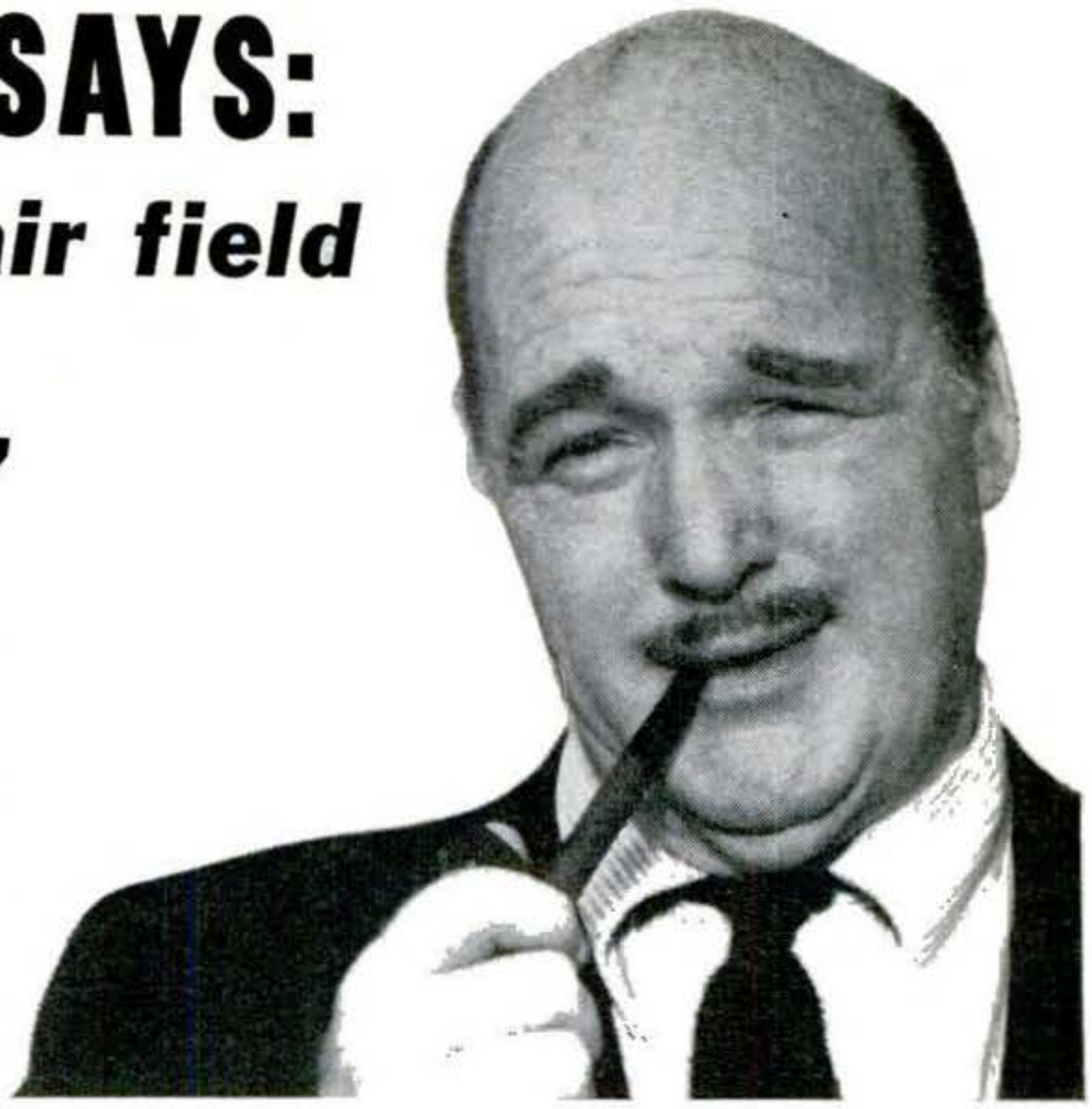
TOM McCAHILL SAYS:

"The appliance repair field is so uncrowded it's almost lonely!"



Someone once said that if you build a better mousetrap, the world will beat a path to your door. In the home appliance business, a lot of enterprising companies have gotten rich peddling a long list of handy electrical gadgets for the home. The trouble is, the dozen or more appliances in the average American home can go on the fritz, and men with the proper training to do repairs are as scarce as knee-length skirts on teen-agers.

Good Appliance Repairmen are a rare breed these days. Those with a little ambition are booked so solidly you can wait days to get somebody to fix a balky refrigerator or cantankerous toaster. Sometime, you have to settle for a bum job from a guy who had no business calling himself an Appliance Repairman in the first place.

This brings me to my point. If you want to make money in a field that's begging for trained technicians, there's a fine, low-cost home-study plan available that teaches you how to handle every type of Appliance repair in detail—including refrigeration, air conditioners, and even small gas engines. This course was prepared by the instructors at National Radio Institute. This is the oldest and largest home-study school in the Electronics/Electrical fields with more than fifty years' experience training men like yourself for new careers or spare-time or full-time businesses of their own.

A few years ago, NRI recognized the increasing demand for trained Appliance Repairmen. They set about preparing well-illustrated, easy-to-understand lessons that teach you how to repair home, commercial and farm Appliances. NRI even added a professional Appliance Tester that's included in their low tuition. With the Tester and a few basic tools you probably already have, you're equipped to service most Electrical Appliances. If you aren't making as much as $4 to $6 an hour in spare time fixing Appliances for friends and neighbors within a few months after enrolling, my name isn't McCahill.

The reason I'm no doubting Thomas, is because the staff at NRI is composed of experienced instructors who guide you through the course with more personal attention than you'd get in many classrooms. With the kind of help they give a student and the kind of course they have, you can be the man in demand in this field—even if you've never tried to rewire a plug, or got fed up with school at the 9th grade.

The best advice I can give you is to clip the coupon below and send for the NRI Appliance Training Catalog. It's free, and there's no obligation. NRI doesn't employ salesmen, so nobody will be knocking at your door. All it will cost you is a postage stamp. Take it from Uncle Tom, the Appliance Repair field needs good men. Now.

Tom McCahill

TOM McCAHILL

APPLIANCE DIVISION, NATIONAL RADIO INSTITUTE
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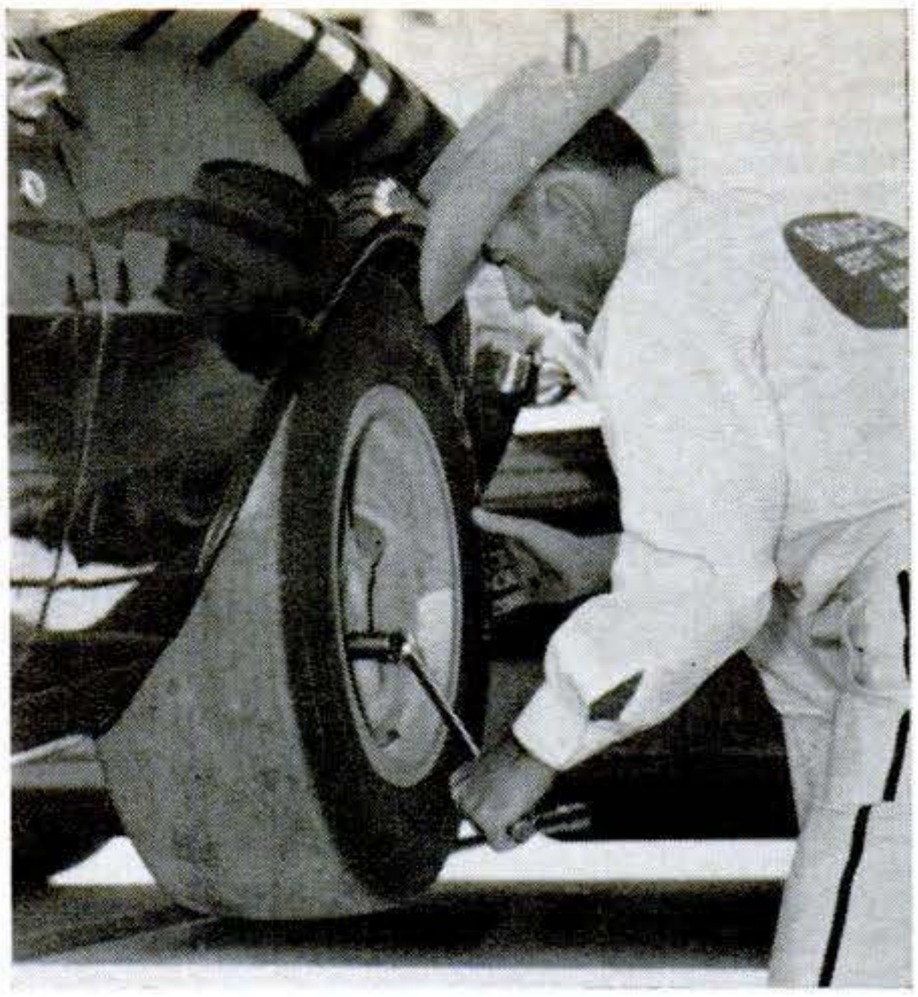
"Say, Smokey—"

A clinic on cars by America's most famous mechanic

Each month in POPULAR SCIENCE Smokey Yunick answers questions on cars—family cars, high-performance jobs, hot rods, and racing cars—selected from those sent in by readers. Got a problem? Ask Smokey. You'll find the address at the end of the column. Please *print* your name and address.



"At about 110 m.p.h., my 1968 GTX, with only 5,000 miles on it, smokes blue out of both exhaust pipes. A mechanic claims it is because the oil bypasses the rings—and that this is normal. Is it? Also, sometimes when I put the accelerator to the floor, the engine will start bucking, and it pops through the carburetor. The timing is okay—what causes this?"

JOHN HARRISON, Waynesboro, Pa.

That blue smoke at 110 per means the rings and/or the valve guides aren't doing their job. Maybe you started playing racer too soon after your car came off the showroom floor. Popping through the carburetor usually means the engine is firing through an open intake valve; the gas mix is too lean, the timing is goofed up, or there's some combination of these troubles.

"I have a '67 Pontiac GP with 15,000 miles on it; tires have been rotated twice with no abnormal wear. But the car is very sensitive to irregularities in the road surface, pulling sharply either to left or to right. This also happens crossing lane-divider strips or pavement joints. A new pair of front shocks at 3,000 miles helped some. The dealer's response, both before and after the shocks were installed, was that there is nothing wrong with the car. Any remedy?"

JAMES W. HITCH, Damascus, Md.

The basic reason for your trouble is that you just can't put 4,000 pounds on a bunch of marshmallows and expect it to go straight at any speed over 25 m.p.h. With the car sitting still, shove back and forth on a rear fender—you'll get the message. The solution is to install Monroe H/D shocks all around, and put on the low, wide-profile tires pumped up hard; also install the heaviest sway bar. To really get it all, jack the car up and check all front and rear suspension bushings and joints. While you are at it, check the front and rear alignment very closely. Check against play in the steering gear. Sorry, that's the way it is to get a really firm control over a heavy car at speed.

"My 1965 Fairlane Wagon has a sooty tail pipe. I can't close off the idle mix on the four-barrel carb with the idle-mixture screw fully closed—the engine continues to run. How come? The carburetor had never been off this low-mileage car, but had flooding problems (corrected under warranty). I don't mash down on the accelerator, but still have never bettered 13½ miles per gallon. I've been driving with the idle-mixture screws fully closed to keep the vacuum as near as possible to 18. Please give me your expert help."

EDGAR L. GEARY, Los Angeles, Calif.

When you run an idle-mix screw all the way in, you just cut the air off and the mix gets richer—you don't cut off the gas. Take this job in to a real good carburetor or tune-up shop. Perhaps they will let you watch while they remedy your trouble. It is not really hard to correct, but must be done "to the numbers." Did you ever figure out how long it took the factory experts to design and test your rig? Don't be disappointed, though, if after all this you still get only about 15 m.p.g.

"I have 60,000 miles on my '62 Mercury Meteor with a 221 cubic-inch V-8. Blow-by

Continued

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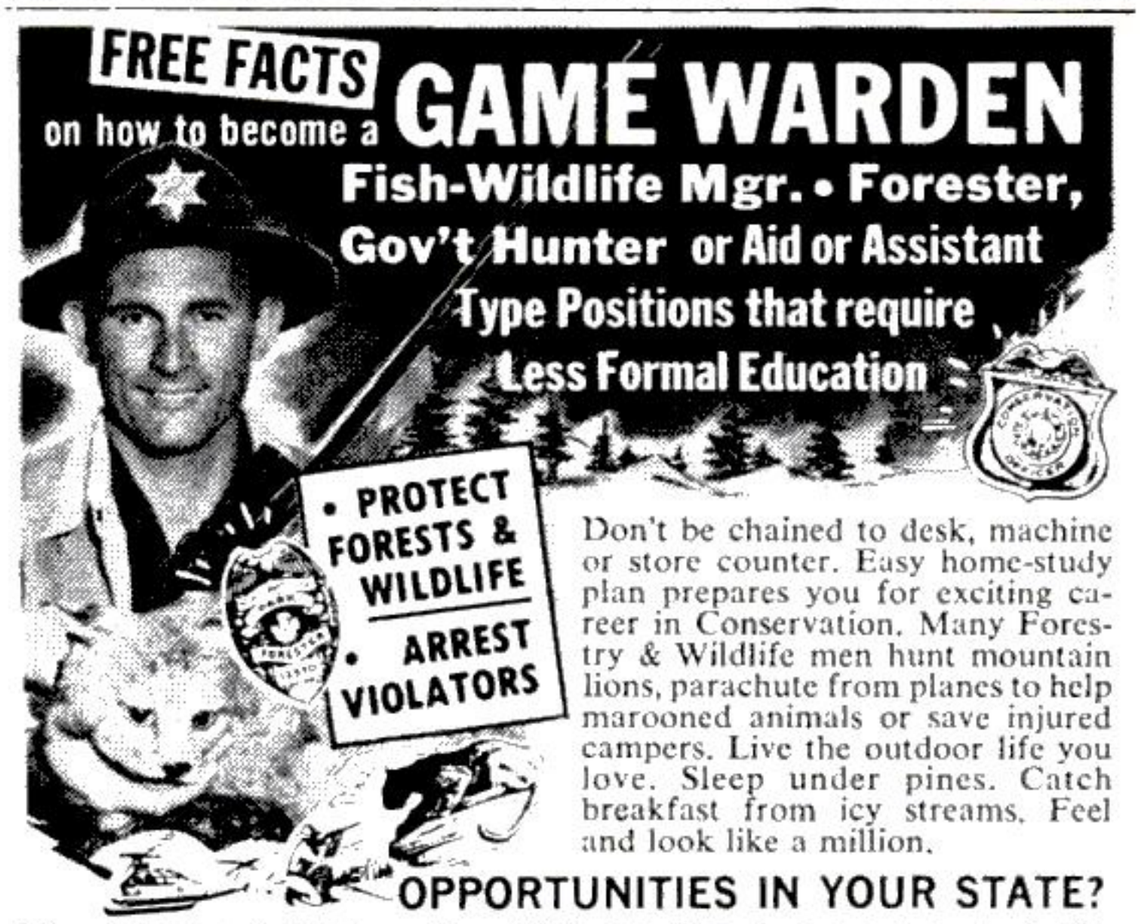

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"Say, Smokey—"
[*Continued*]

fumes come from under the car almost as if it were on fire. Would new rings solve the problem? Is this an ailment of all Ford products?"

EDMOND WAGES, Decatur, Ga.

Not just Ford's fault. This ailment is common to, and comes prematurely on, all small engines that have to haul a heavy car around, as compared to the fine performance of the larger engines. You've got a case of TB of the cylinders in this car and you'd better have it rebuilt or start looking around for a good swap to avoid worse trouble.

"Here's a real shocker! I was told that pouring water down a carburetor would clean the carbon out of an engine. It's supposed to be poured gradually, while the engine is running on about half throttle. Please comment."

RAUL BURCIAGA, El Paso, Tex.

Well, Raul, that is right—to a degree. Water will clean a certain amount of carbon out, but it could do so much harm to the engine while cleaning carbon that you might wish you had left it alone. For that matter, a little sand could clean some carbon, too—but I'll leave the rest of what happens to your imagination.

"I recently purchased a new 1968 VW. After three days of driving, the brakes began to chirp and squeal in an irritating manner whenever I applied them. The mechanic at the dealership told me it is due to extra-hard brake linings on this model, and that a lot of VW owners will have to learn to live with it."

BOB GOGAR, Las Cruces, N.M.

First try having the brake linings cleaned, or sanded, to get the film off; then have the drums cleaned, and checked for a smooth finish. If the noise continues, see if the brake anchors and shoe retainers are as tight as they should be. If all the above fails to stop the concert, head for your local brake shop for a lining change. It is possible that you didn't break in the linings properly, causing this condition yourself. To break in new linings, you should make only mild stops, to avoid overheating the linings until full contact is accomplished by normal wear. That can take up to 2,000 miles of riding.

"Recently, I was told by mechanics that the factory allows 1/64-inch play between upper and lower front-end ball joints on my

Continued

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10 Reasons why RCA Home Training is

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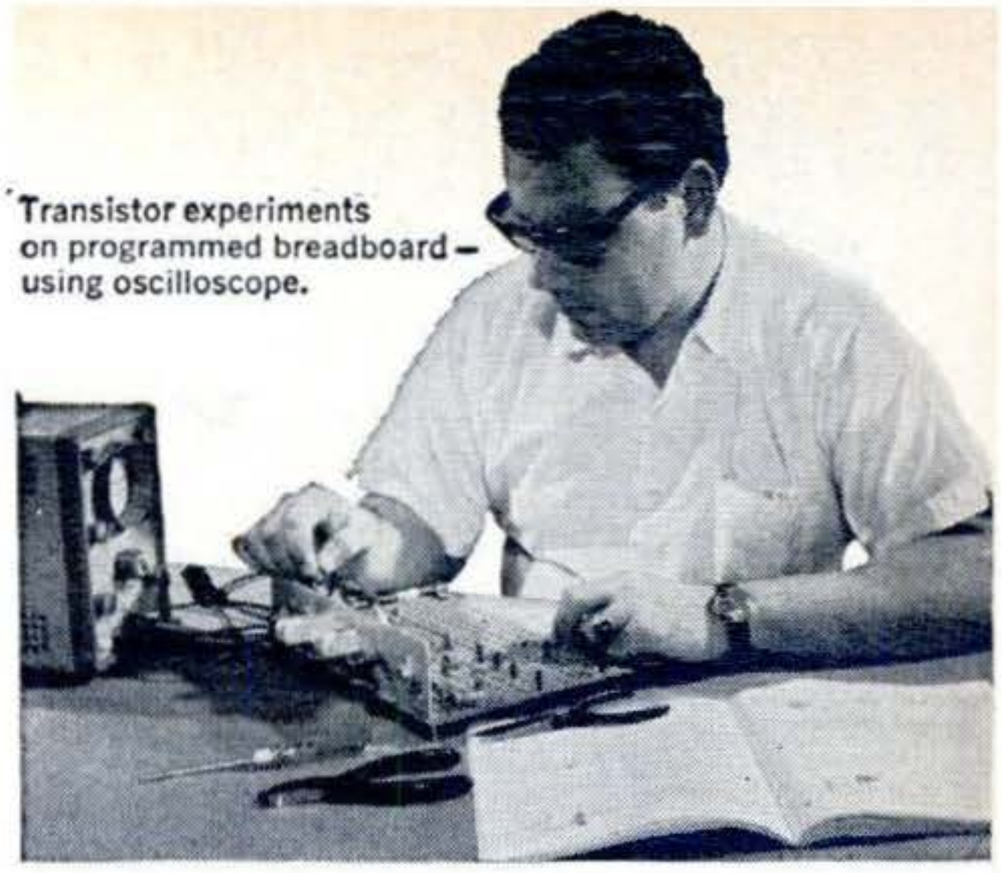

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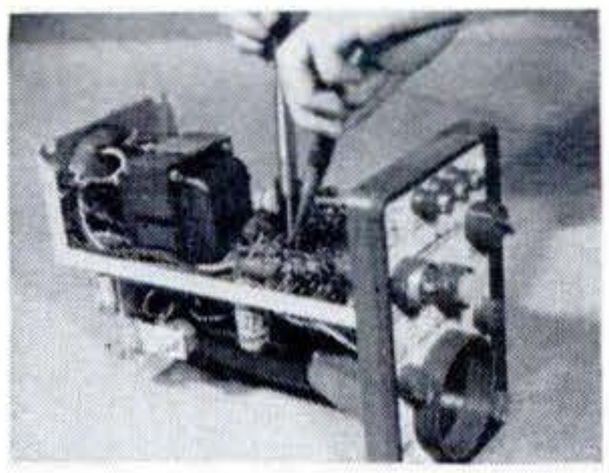
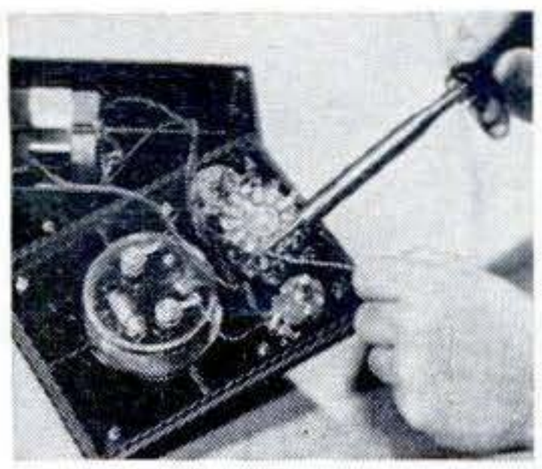


Construction of Multimeter.



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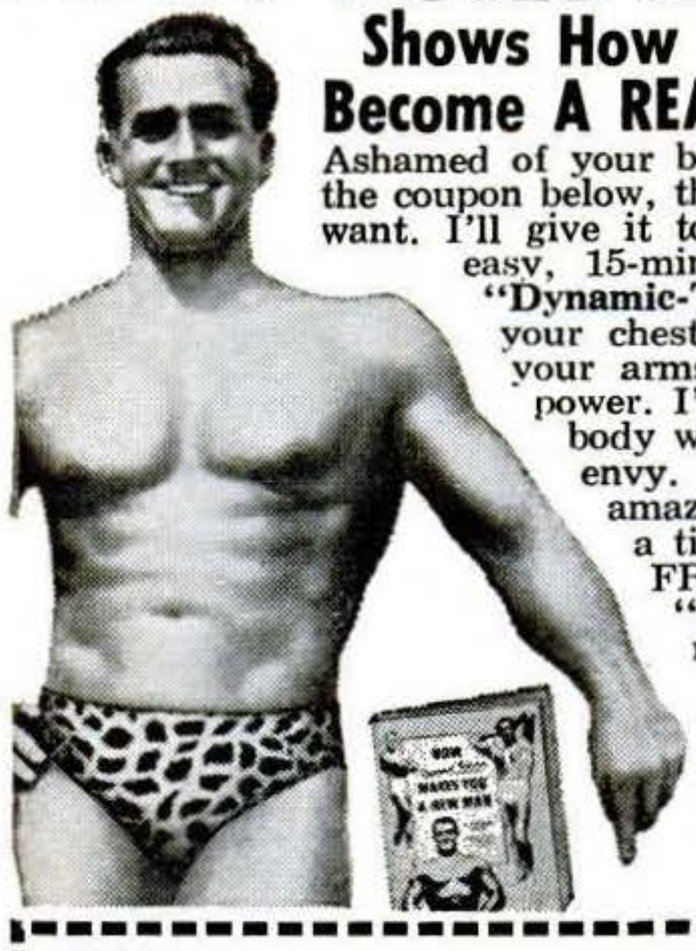

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"Say, Smokey—"
[*Continued*]

1961 Chevy six. What would be the safety hazard in driving with 1/32, 3/64, 1/16 inch, or more?"

GEORGE SCANDA, Seattle, Wash.

Don't take a chance—keep 'em tight, George! You're in trouble in any car when anything other than the steering wheel steers it. The faster you go with that trouble, the worse the danger. The factory mechanical tolerance is one thing—say up to 1/32 inch. But the sensible tolerance is under the point where road wander starts. Get all looseness out of that steering gear, and live to write me again.

"My 1968 Cadillac burns a quart of oil in 200 miles, but the oil level does not then go below the "add-a-quart" mark on the dipstick. Other Cadillac owners have voiced the same complaint to me. Should I leave the level one quart low, or could this damage the engine?"

DR. J. H. GRANT, Chicago, Ill.

Running her a quart low might not hurt anything, though it keeps your reserve a little short. Actually the oil in the pan is not the real issue. The real problem is keeping the pump pickup submerged while under way (on full-throttle acceleration, hard cornering, steep hills, etc.). Try writing to "Uncle Bob," Service Director of Cadillac Motors Car Div., 2860 Clark Ave., Detroit, for his plan to stop that first quart loss.

"I've spent at least $25 trying to balance the front wheels of my 1966 Checker Marathon, which is almost like new otherwise. I tried static and dynamic methods and checked the tires for roundness, too. Will those patented "gyroscopic" devices balance my wheels, or will I just be throwing 10 bucks away?"

G. KOSTYK, Canoga Park, Calif.

Of course there's more than one way to skin a cat, but personally I'd use that 10 bucks toward getting those tires really trued and balanced—or even changing to one of the new bias/belted tires. When getting wheels balanced, be sure it is done on the car, to balance the brake drums and hubs at the same time. A good *round* tire on a true wheel and hub assembly, balanced and aligned, doesn't need any other gadgets.

Got a question on autos? Send it to:
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How Harold Dail Made $7,975.00 In 59 Days!

By Tom Harding

The true story of Harold Dail could happen only in the fantastic world of Accident Investigation.

Where else could a man with no experience and only average education go out and pick up a check for nearly $5,000 for 22 days work?

Where else could this same man later go out and earn at the rate of $135.00 a day for 59 straight days?

Is Harold Dail some kind of a money-making genius? Not at all. He's just an average man who had the good sense to take some training in a field that's bursting with opportunity.

It all began when Dail was working as a night clerk in a hotel in Barstow, Cal. It was a dull, low-pay job. There obviously wasn't much of a future. But Dail wasn't about to give up.

The Big Break

He enrolled with Universal Schools of Dallas for correspondence training in Accident Investigation. He started reading lessons-by-mail in his spare time.

Then came the big break. A large furniture store burned in Long Beach. Dail quickly reviewed one of his Universal lessons then hurried out to see the owner of the store. He offered to represent the owner in obtaining an insurance settlement.

In just 22 days, working entirely from directions in his Universal lessons, Dail obtained a settlement for $91,275. His fee—$4,563.75!

Almost without knowing it, Harold Dail had become what is known as a Public Adjuster. The Public Adjuster works as an independent operator. He helps people settle insurance claims. It is only one of the many money-making careers open today in the booming field of Accident Investigation.

A New Career Opens

But this was only the beginning for Harold Dail. His new career opened up like the door to a bank vault.

When a large area of Los Angeles was swept by fire, Dail went to work in earnest. His Universal training turned into a jackpot. He helped 21 businessmen handle their insurance claims and made $7,975.00 in 59 days. That's an average pay of $135.00 a day!

Today Harold Dail has made so much money in Accident Investigation that he spends his summers on his ranch

Amazing Things Can Happen To You In This Big-Money Industry

near Kingman, Arizona. He's also building a sub-division in Barstow—the same city where he was once merely a night clerk in a local hotel.

"If it hadn't been for my income from Public Adjusting I wouldn't be financially able to carry on this project," Dail writes. "If it hadn't been for the training of Universal Schools I wouldn't have been in the 'know' about Accident Investigation in the first place. I owe a lot to Universal Schools."

You Can Train, Too

The story of Harold Dail is unusual. His income is far above average for the field. But it shows what a man can do in Accident Investigation when he is trained to take advantage of the opportunities around him.

Now you can take exactly the same training Harold Dail had. You can do it easily in your own home, in your spare time, and at low cost.

You need no experience, no college education. There's no equipment to buy. No classes to attend. Keep right on with your present job until ready to switch.

And when you are ready, Universal gives you free, nation-wide job placement service. Universal has trained and placed more men in Accident Investigation careers than any other organization.

Men Urgently Needed

The need for more trained men in all areas of Accident Investigation is absolutely critical today. This huge, growing $19 billion industry must investigate and settle some 22 million accidents and losses a year! And the job gets bigger every month as the accident rate goes up and up.

There simply are not enough trained men in the country to handle this enormous workload. That's why hundreds of companies have standing requests with Universal for names and addresses of all our graduates.

Free Book of Facts

We can't begin to tell the whole story of this huge, exciting business here. But we do tell you all about it in an exciting, free book which you can have for the asking. There's no obligation. No salesman will call.

Learn about the 3 major careers open now in Accident Investigation. Read how clerks, truck drivers, laborers, factory hands have moved up to professional pay and standing with the help of Universal. (We give you names, addresses, earnings.)

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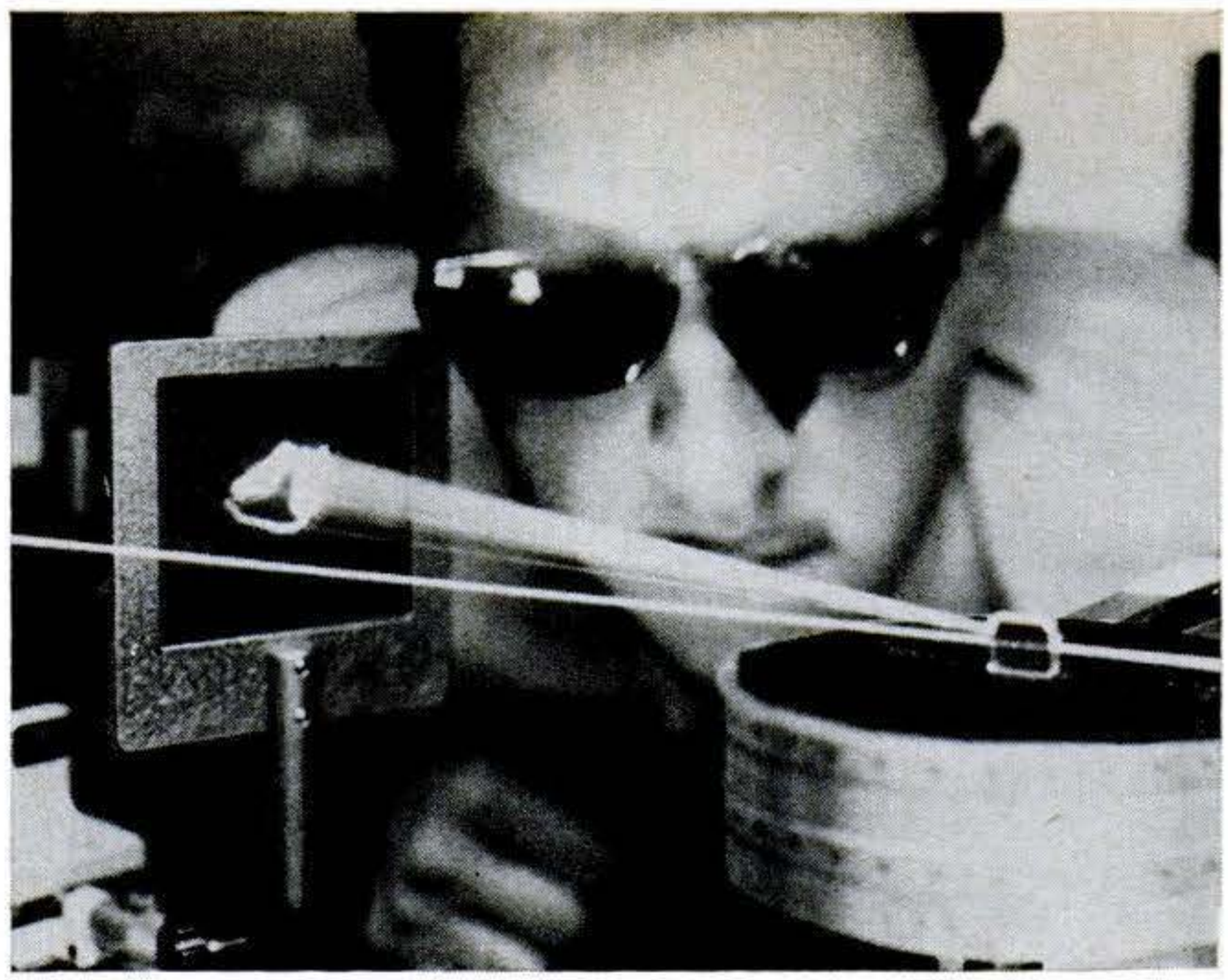
Science Newsfront

Last-minute news and notes to keep you up-to-date

By W. STEVENSON BACON



As many as 1,000 3-D pictures or holograms can be stored inside a crystal smaller than a lump of sugar with a new Bell Labs technique. With such an immense storage capacity, the crystals may also be used as optical memories for computers. The tiny crystals are of lithium niobate. When an intense laser beam hits one, electrons are freed and set up an internal electric field that causes a change in the crystal's refractive index. After one hologram is formed, the crystal is simply rotated a fraction of a degree to record a second. The images can be erased just by heating the crystal to 338 degrees. Another bonus: It takes much less light to reconstruct an image than with ordinary holograms. The photo above shows a reconstructed 3-D image of a telephone.

Boot-sole radios are spying on skiers as they go through their paces this winter. Reason? At least two-thirds of the 30,000 major injuries each year could be prevented if "releasible" bindings would come off when they're supposed to. In a University of Pennsylvania project, ski boots fitted with special clamps, springs, and transducers are converting physical activity to electronic signals. They measure vertical and lateral forces at heel and toe, and longitudinal force along the ski, radioing the data to a monitoring point. The trouble with present bindings, according to Dr. Lawrence D. Sher who is heading the study, is that they're adjustable. The ideal: a nonadjustable binding that would release if injury were imminent.

Model cars are rerunning real accidents, and the technique may be used to find out who's to blame when full-size vehicles collide. The models are aluminum blocks with the weight distribution of standard-size sedans. They're spring-loaded, and at a signal they shoot forward at speeds equivalent to 10 to 40 m.p.h. An overhead strobe camera takes 25 pictures a second of the approach, crash, and trajectories of vehicles after impact. Accidents are staged on a table calibrated in squares. University of California researchers started with data from real, full-scale collisions; now they can accurately duplicate the results with models. The engineers hope both to improve car design and simplify the legal aftermath of accidents.

Ultra-efficient motors and generators, frictionless bearings, and no-loss power transmission lines are a big step closer. Workers at Bell Labs, together with scientists at the Universities of California and Chicago, have found a material that becomes superconducting at the highest temperature yet reported: 20.7 degrees Kelvin. When a material becomes superconducting, it loses all resistance to the flow of electricity. The new superconductors are a mixture of niobium, aluminum, and germanium. Significance of the discovery is that there will be superconductors that can be cooled in liquid hydrogen (it boils at about 20 degrees K.) instead of the much more expensive liquid helium (boiling point, four degrees K.).

A way of sending power through your skin could make an electrically operated artificial heart practical. A relatively enormous 30 watts of energy can be transferred inside the body with a compact, efficient transformer just developed at New York University. The unit is made in two disks, each about three inches in diameter and an inch thick. Ferrite cores make possible the small size and keep the weight of each half down to

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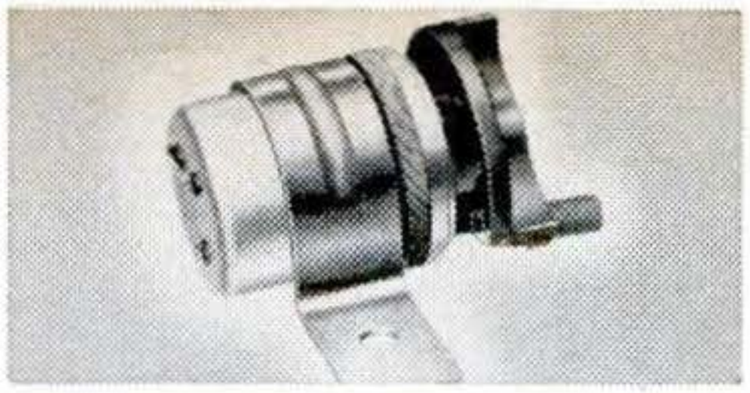

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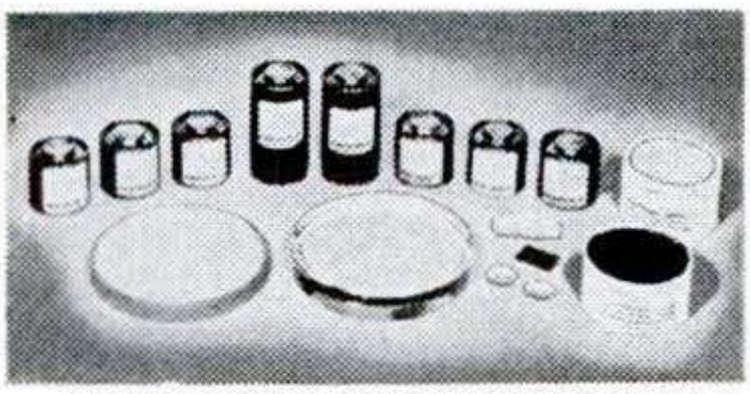

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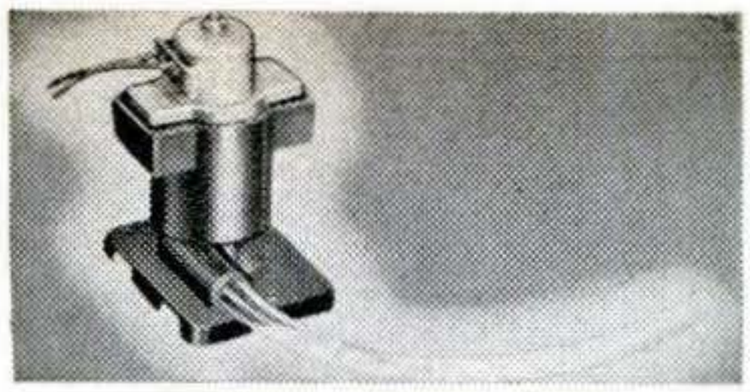

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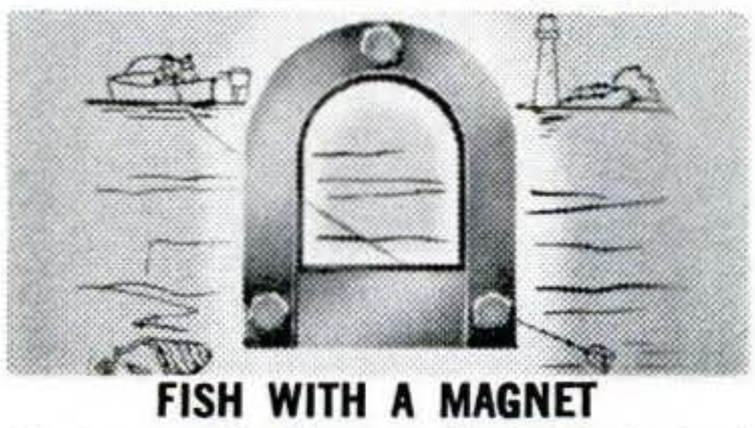

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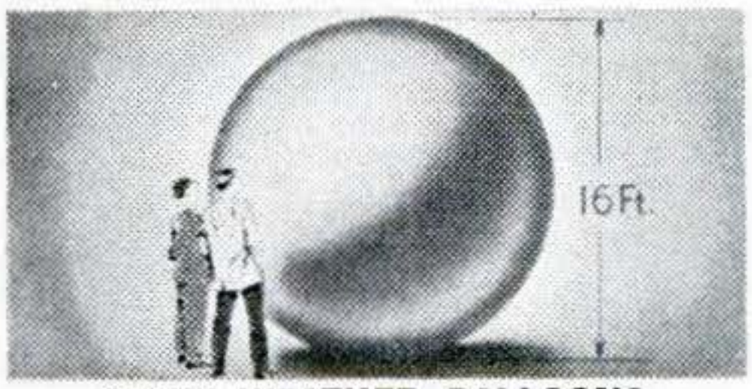

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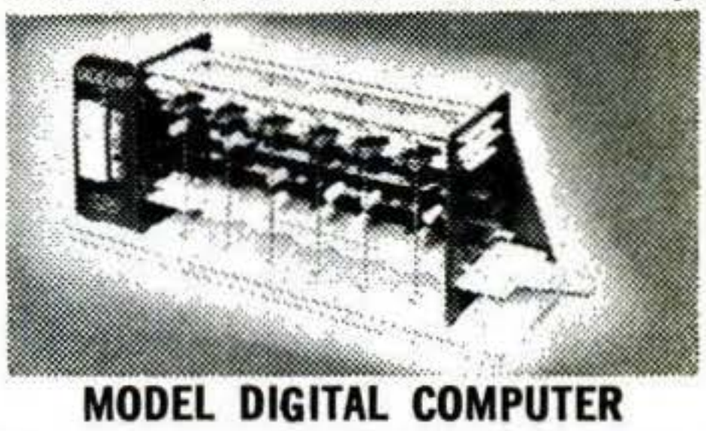

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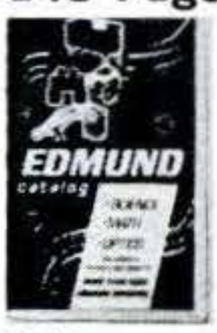

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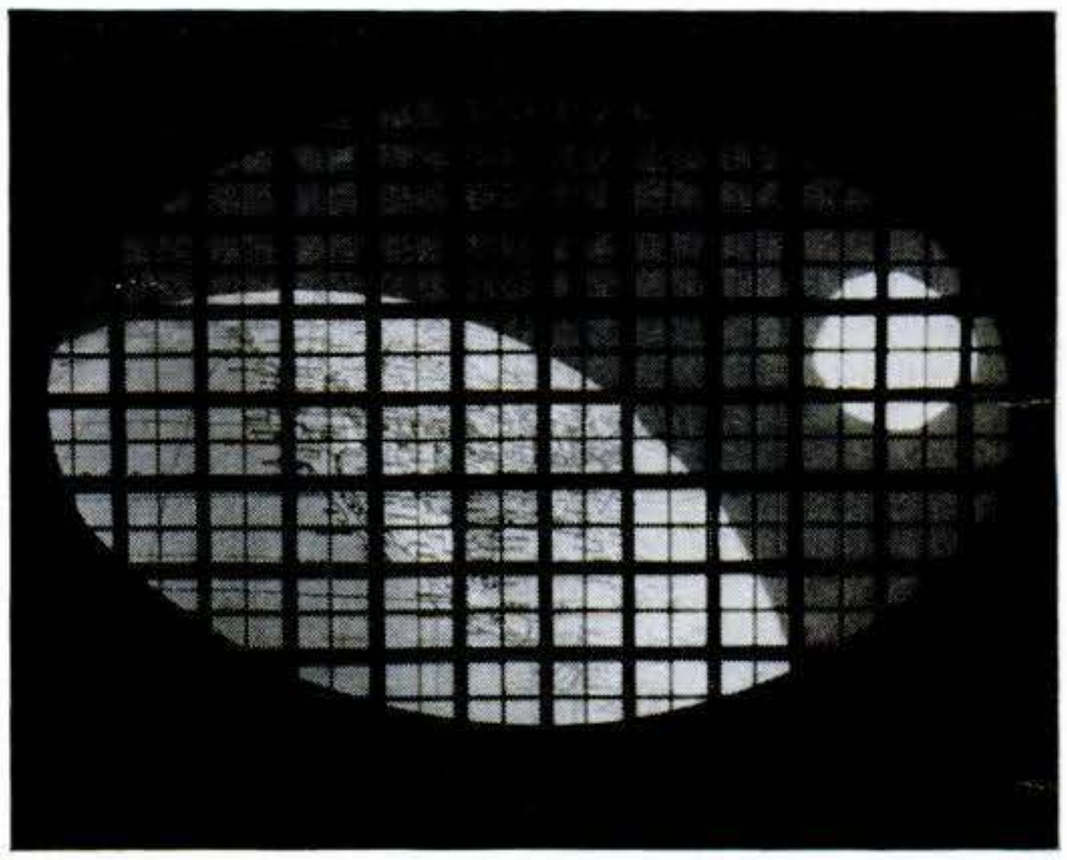
Transparent rubber windows for spaceships, collapsible space stations, and even underwater structures may be made with a tough new material being developed for NASA by



Uniroyal. The windows are a key component for inflatable structures to house space expeditions, either in orbit or on the moon. Researchers came up with a combination of transparent silicone polymer reinforced with filaments of fiberglass. It's so strong that it has withstood pressures up to 59 pounds per square inch—the strength of the joint between window and structure. The window itself has a tensile strength of 840 pounds per inch. The collapsed structure would take little of a spacecraft's payload volume, could be quickly inflated in outer space.

Yet another flat TV screen is being developed, this one based on a mosaic of tiny crystal fragments emitting red, blue, and yellow light. Working with cadmium sulfide crystals, Dr. William W. Anderson of Ohio State has made them emit light when an electric current is applied by "doping" them with phosphorus ions. Although the light output is still low, it is believed the system could be 80 percent efficient (a light bulb is about 10 percent). The principle of the TV screen would be similar to that in early color films—one type was covered with microscopic grains of starch dyed in three colors.

A holographic check of your car tires might some day be routine at service stations. For the present, however, this highly experimen-

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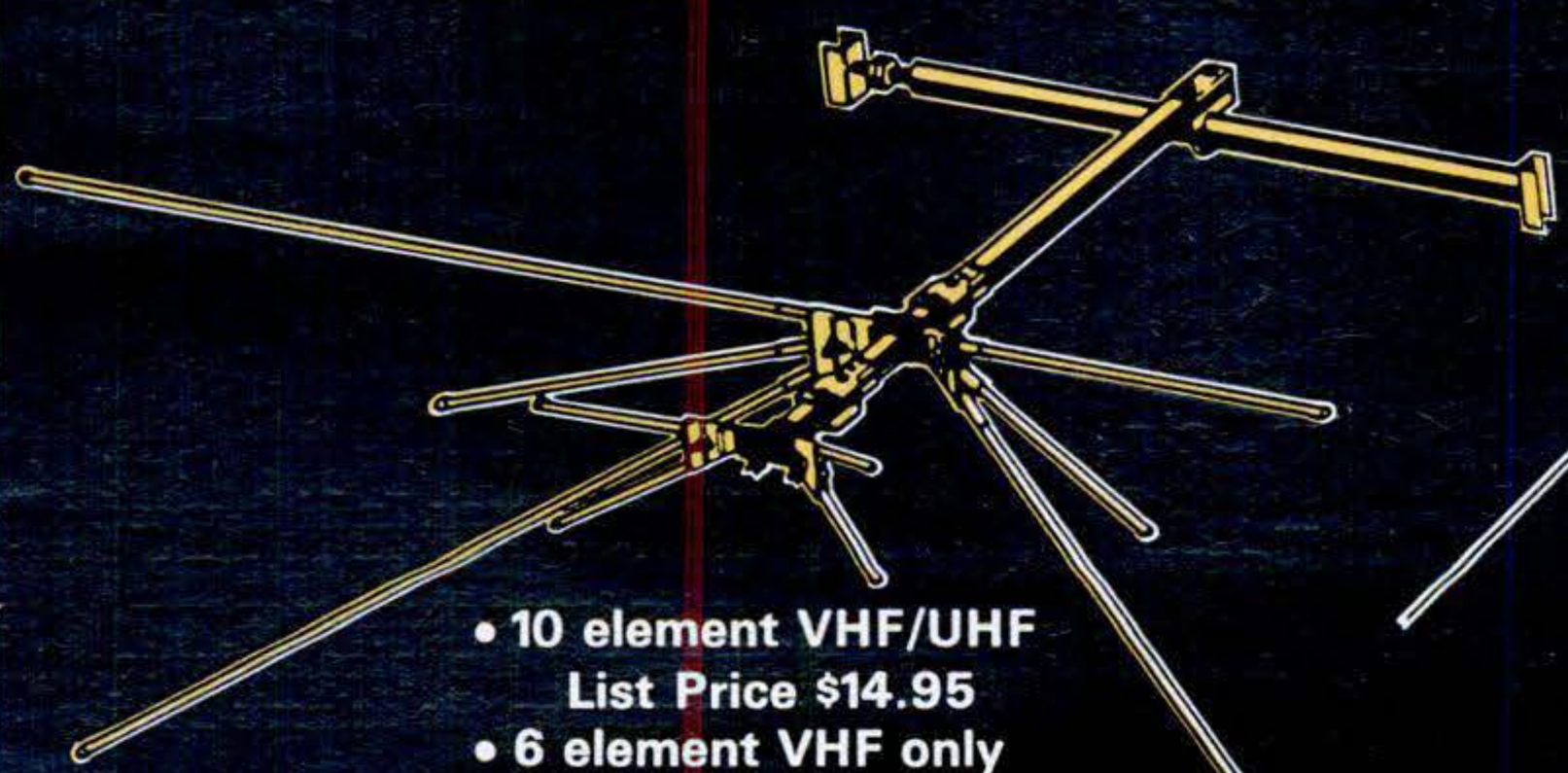

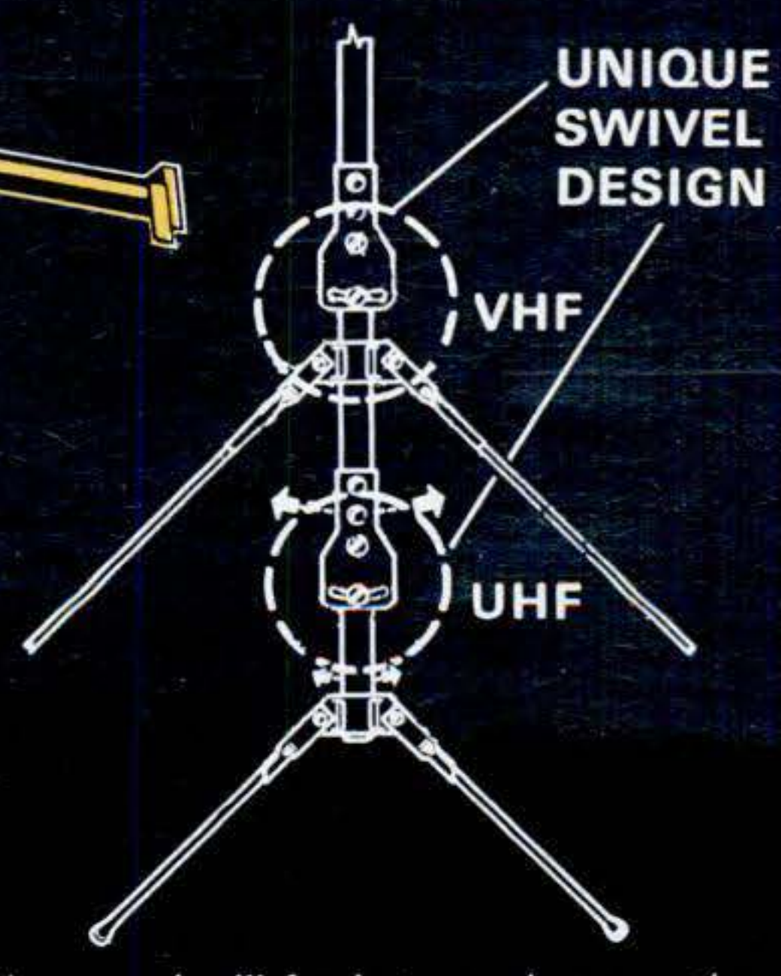

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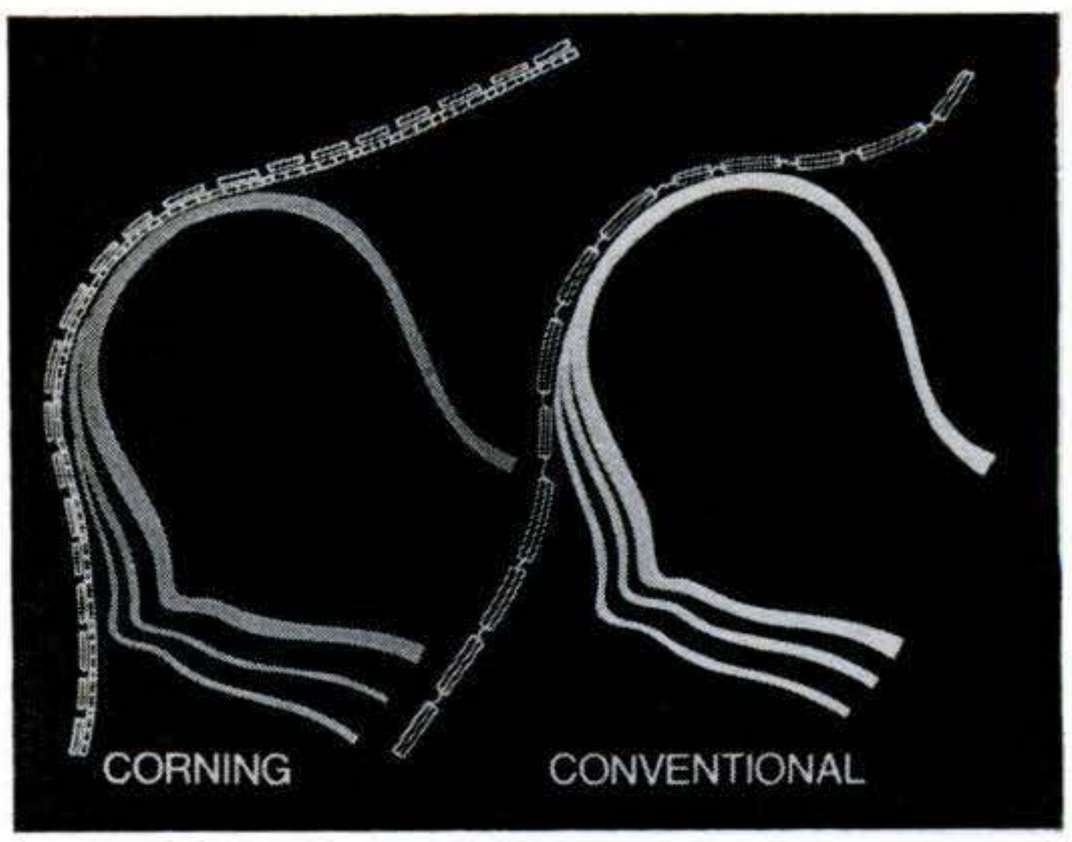
tal technique is helping researchers detect hidden flaws, voids, or cracks in new tires without destroying the tire itself. Air pressure causes an inflated tire to "grow" slowly and slightly. If it's normal, this expansion will be uniform; otherwise, hidden cracks, flaws, separations, and blisters develop. Normally, they're hard to spot, but 3-D holograms made with a laser tend to pinpoint them. A holographic plate shows irregularities as concentric circles of light and shadow.

A thinner, lighter auto windshield that reduces cuts and has a "fishnet" effect in accidents will be used in some 1970 cars. Because of its thinness (.205 inches compared to .280 for conventional windshields), it defrosts 30 percent faster in winter. Secret of the new Corning-developed material is a chemically strengthened glass center pane that breaks into thousands of granules that do not cut. An inside plastic layer with high penetration resistance is added. In low-speed accidents, the driver receives a slight bump and the



windshield doesn't break. In high-speed collisions an annealed-glass outer pane breaks first, the center layer absorbs energy before granularizing, and the plastic layer "balloons" out to cushion the driver's head.

Youngsters who balk at taking a bath have science on their side. Incredible as it seems, people who scrub themselves remove an insignificant proportion of bacteria and may irritate the skin, inviting an even greater bacterial invasion. This, at least, is the conclusion of Dr. Ralph C. Richards of the University of Utah, the most recent participant in a research project dating back 30 years. Among the findings: Campers who stay in the field for a week or two without taking a bath have a lower bacterial count at the end than when they started. PS

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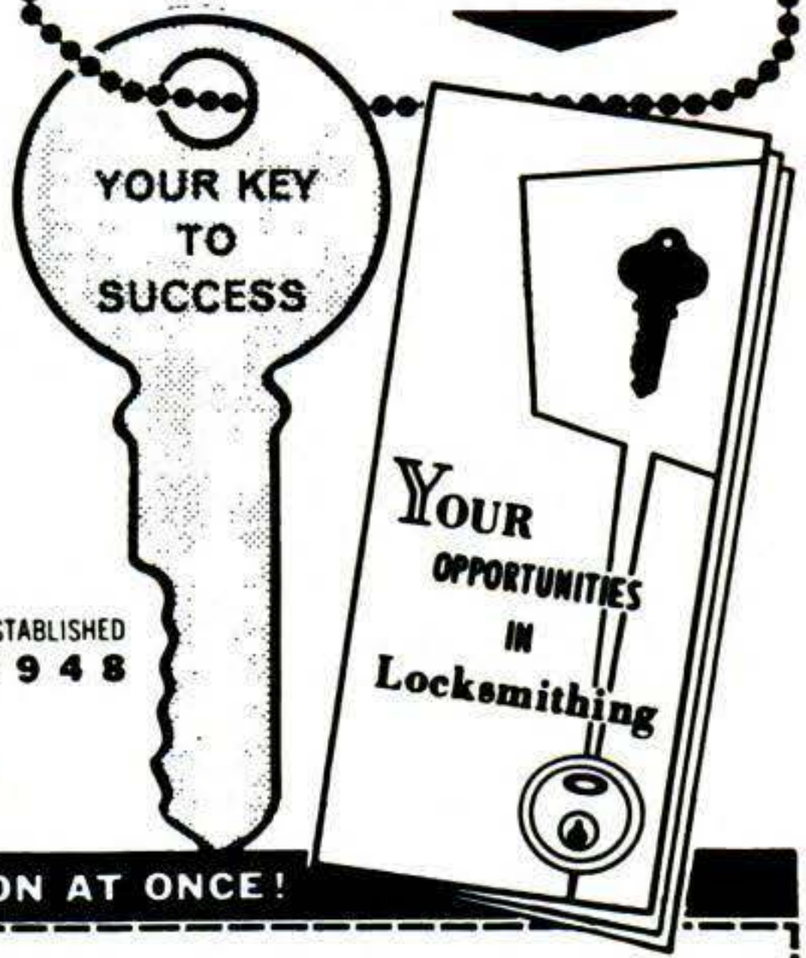

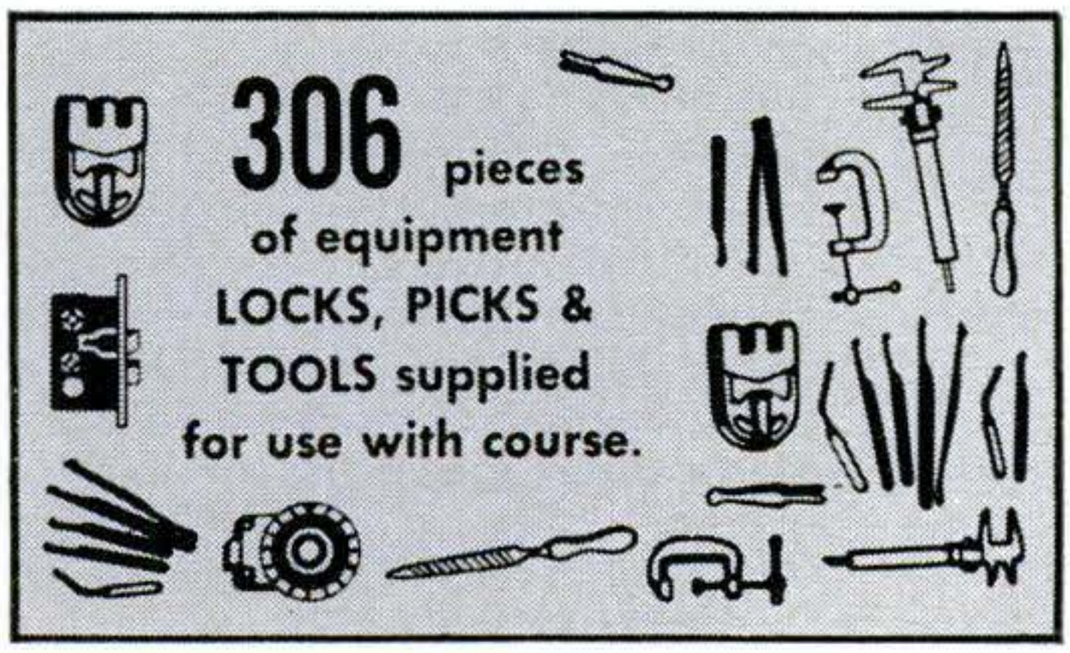

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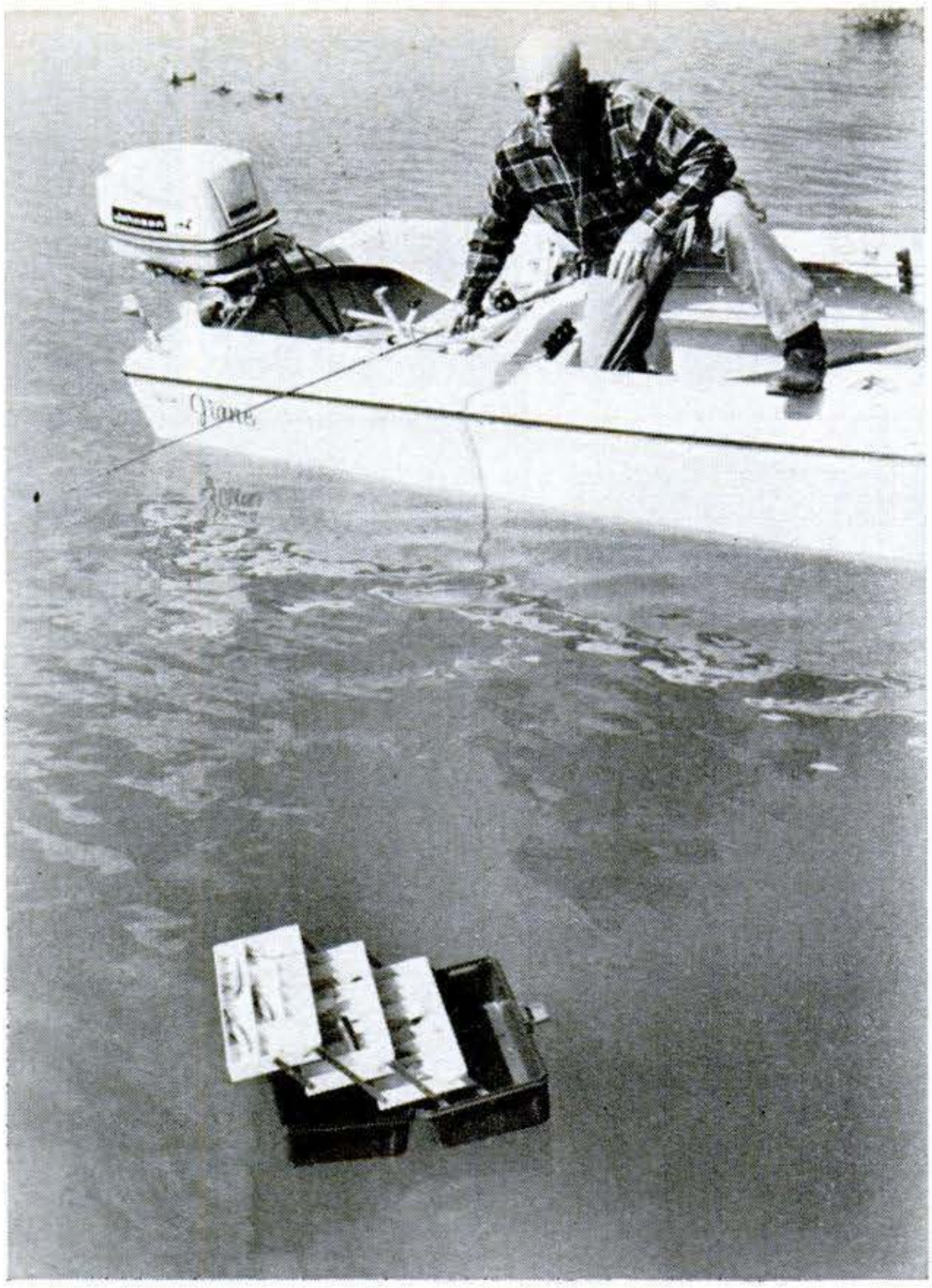
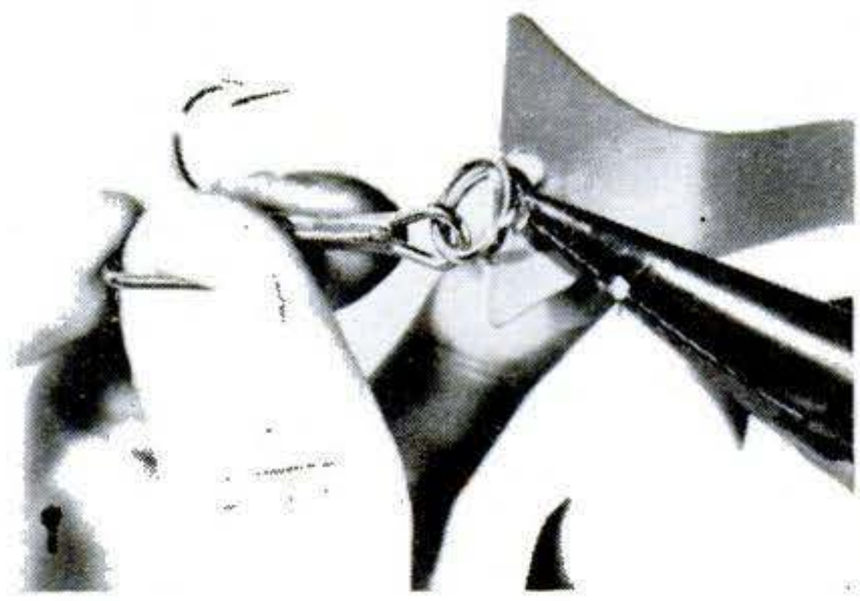


Overboard tackle box floats

A watertight tackle box gives fishermen a second chance because it won't sink no matter how much fishing gear it contains. Called the Adventurer, it's made of polypropylene plastic in four sizes from 12 to 20 inches long. Prices run from $3.95 to $29.95, through sporting-goods and fishing-tackle stores. Vlchek Plastics Co., Middlefield, Ohio.



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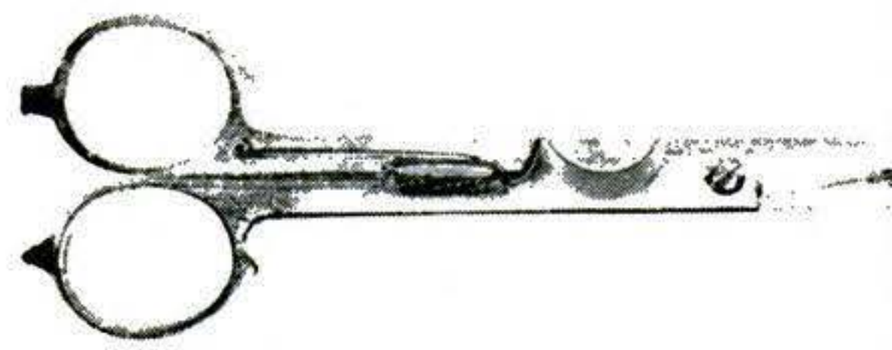
Careful tempering insures that the Fix-It split ring, shown being used to attach a treble hook to a lure, will return to its original shape without distortion. The rings have other uses, too—outdoors and in home and shop. You get an envelope of 10 in assorted sizes for 15 cents. The Worth Co., Stevens Point, Wis. 54481, makes them.

Deluxe fisherman's knife from Finland

This Fish'N Fillet knife features a six-inch progressively tapered stainless-steel blade with a hand-ground edge; it stays sharp through repeated use, yet can be resharpened with a hand hone. Flexibility allows even most delicate filleting. Knife and oxhide sheath with hand-tooled embossings (Presentation Model), $7.95. Normark, 1710 E. 78 St., Minneapolis 55423.



One tool does many jobs

Designed to lighten the load carried by anglers, this compact one-piece tool kit is a hook remover, weight crimper, weight opener, line cutter, pliers, awl, screwdriver, and bottle opener. It can also be put to use in the home—or in the yard for pruning. The tool costs $4.95 from Central Products, 533 Ash St., Central City, Pa. 15926.

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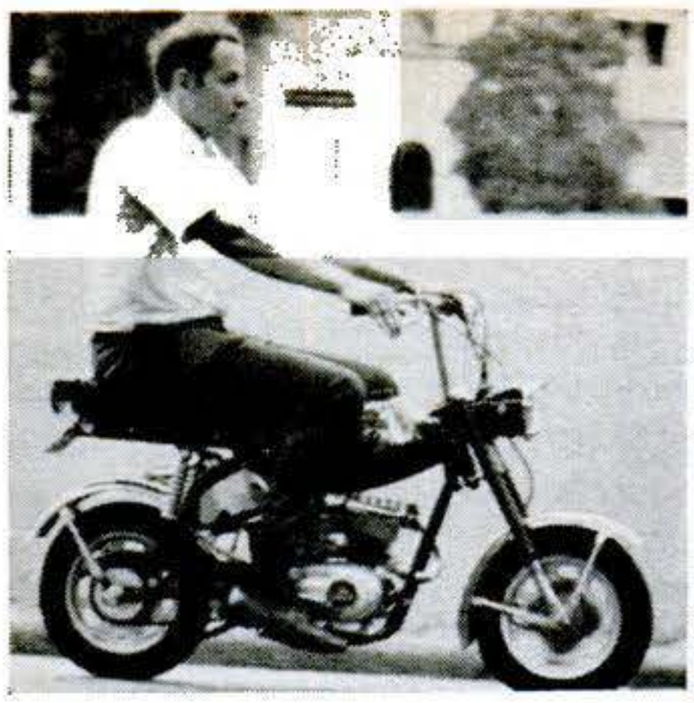
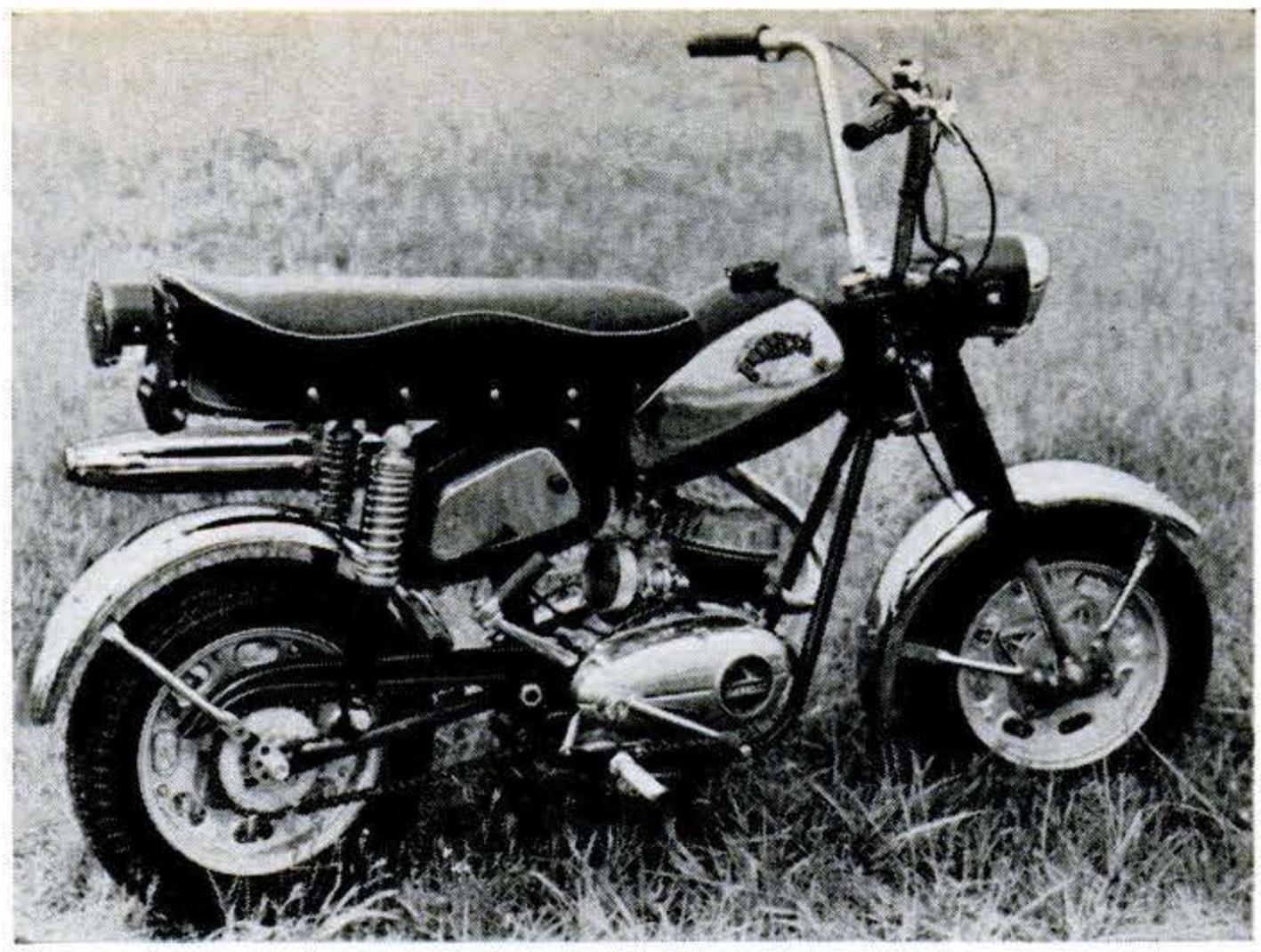


With 10-inch wheels and oil-damped springing front and rear, the Broncco gives a comfortable ride. The seating position is the same as on a full-size bike and calls for no excessive knee-bending. Engine puts out five hp.



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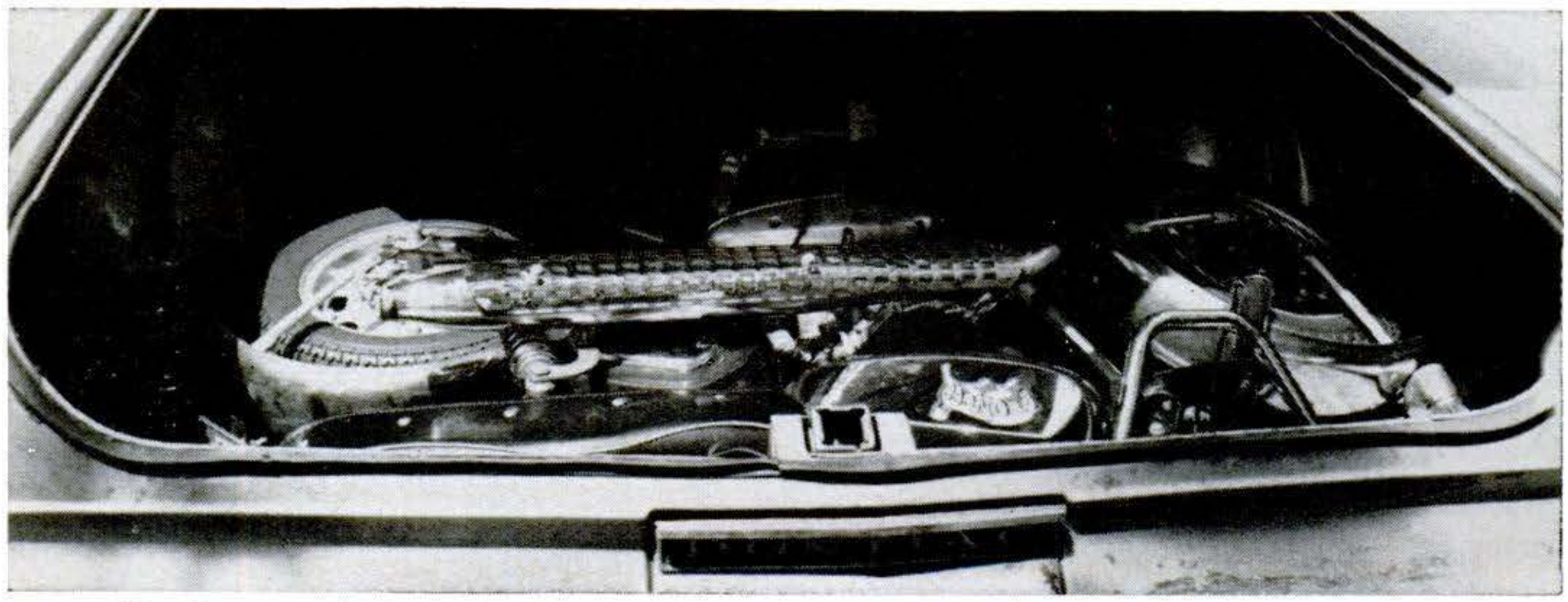
Fuel economy is about 120 miles per gallon. Its engine puts out five hp. at 6,500 r.p.m. Top speed is around 45.

By removing four screws and taking off the handlebars, the entire cycle can be stowed in even a compact car's trunk. If you've got the space to spare, this little machine can be great to take along on a weekend outing or vacation trip to add to your fun.—*Ted Robinson.*



The Broncco folds up and stows in the trunk of a car—ready for weekend pleasure.

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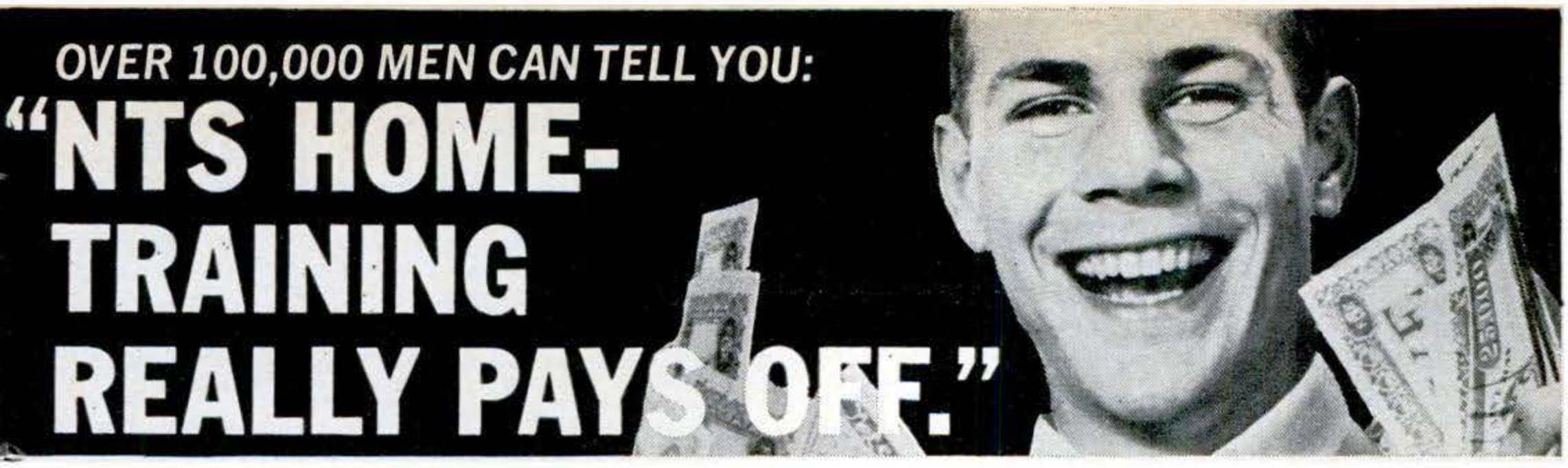

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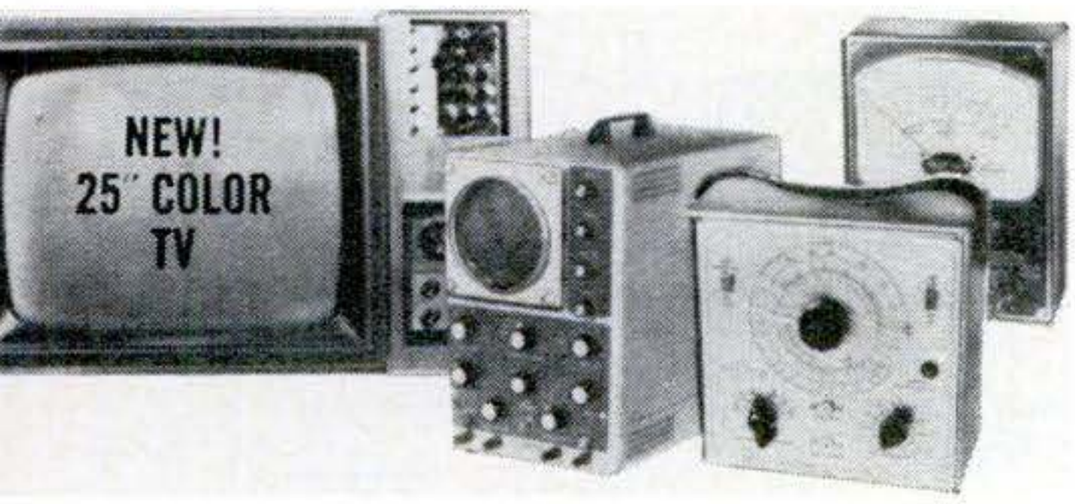

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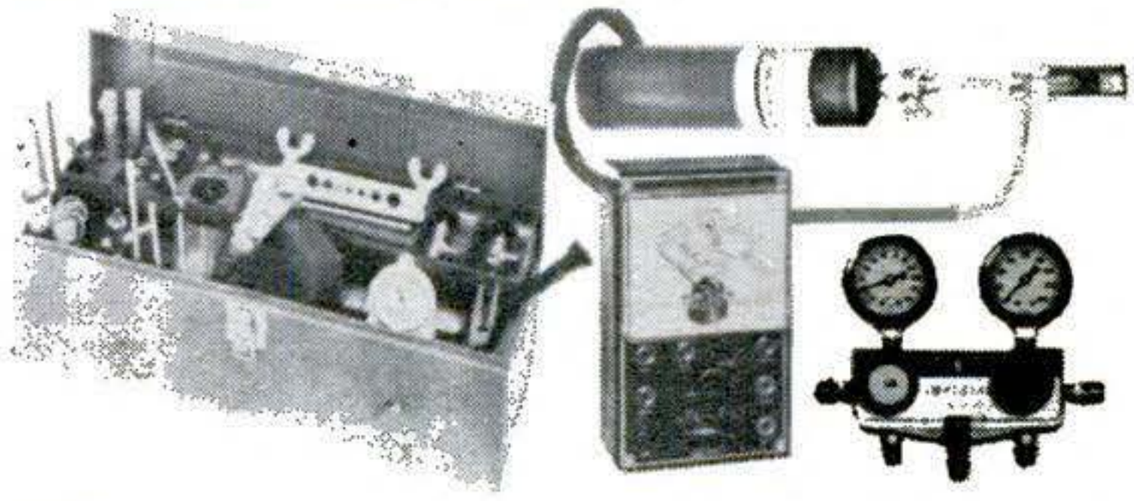

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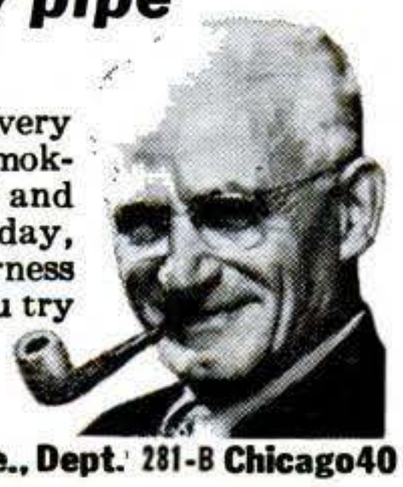

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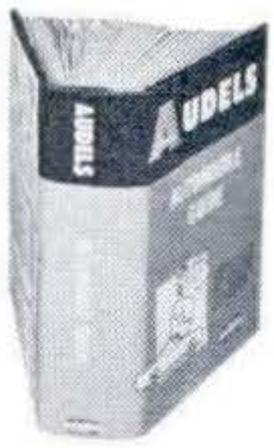

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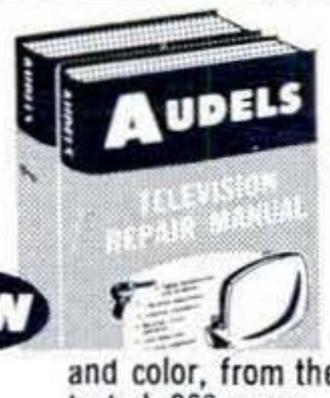

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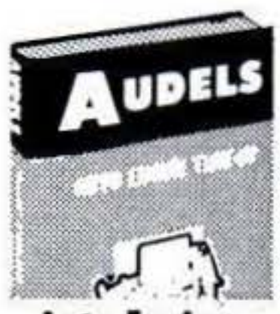

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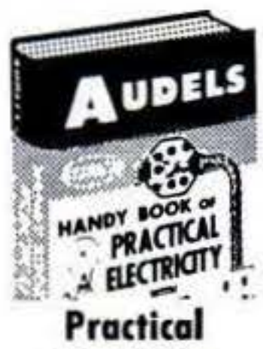

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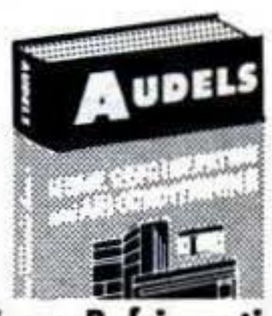

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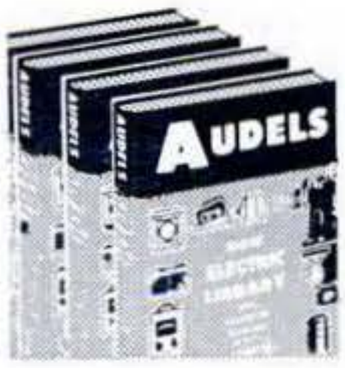

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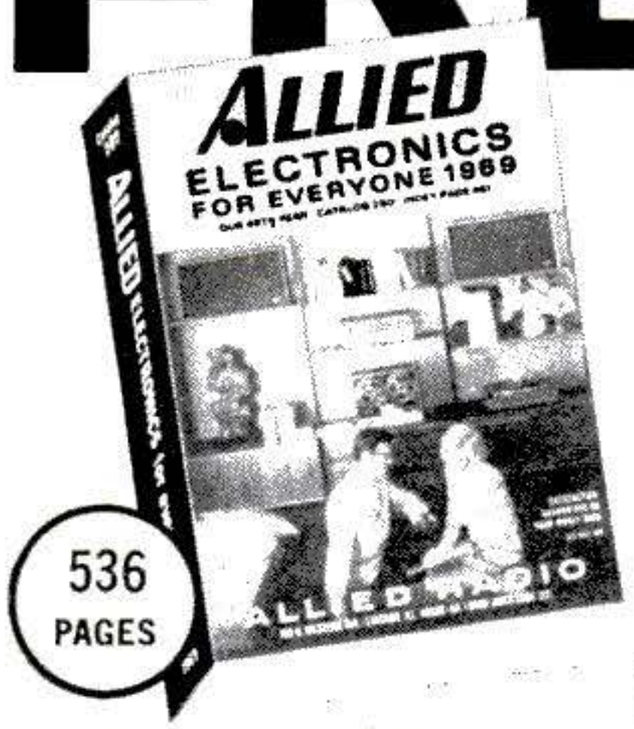

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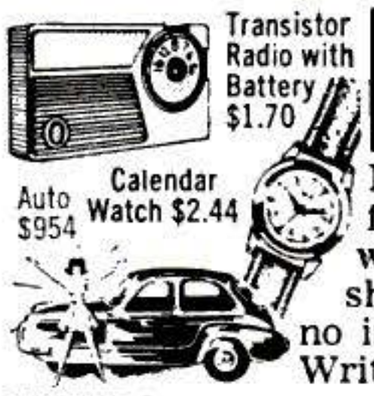

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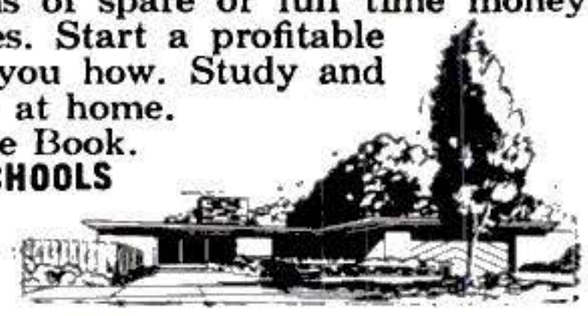

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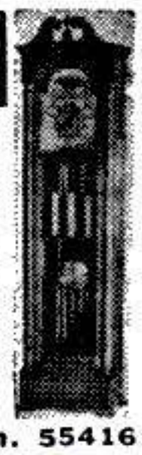

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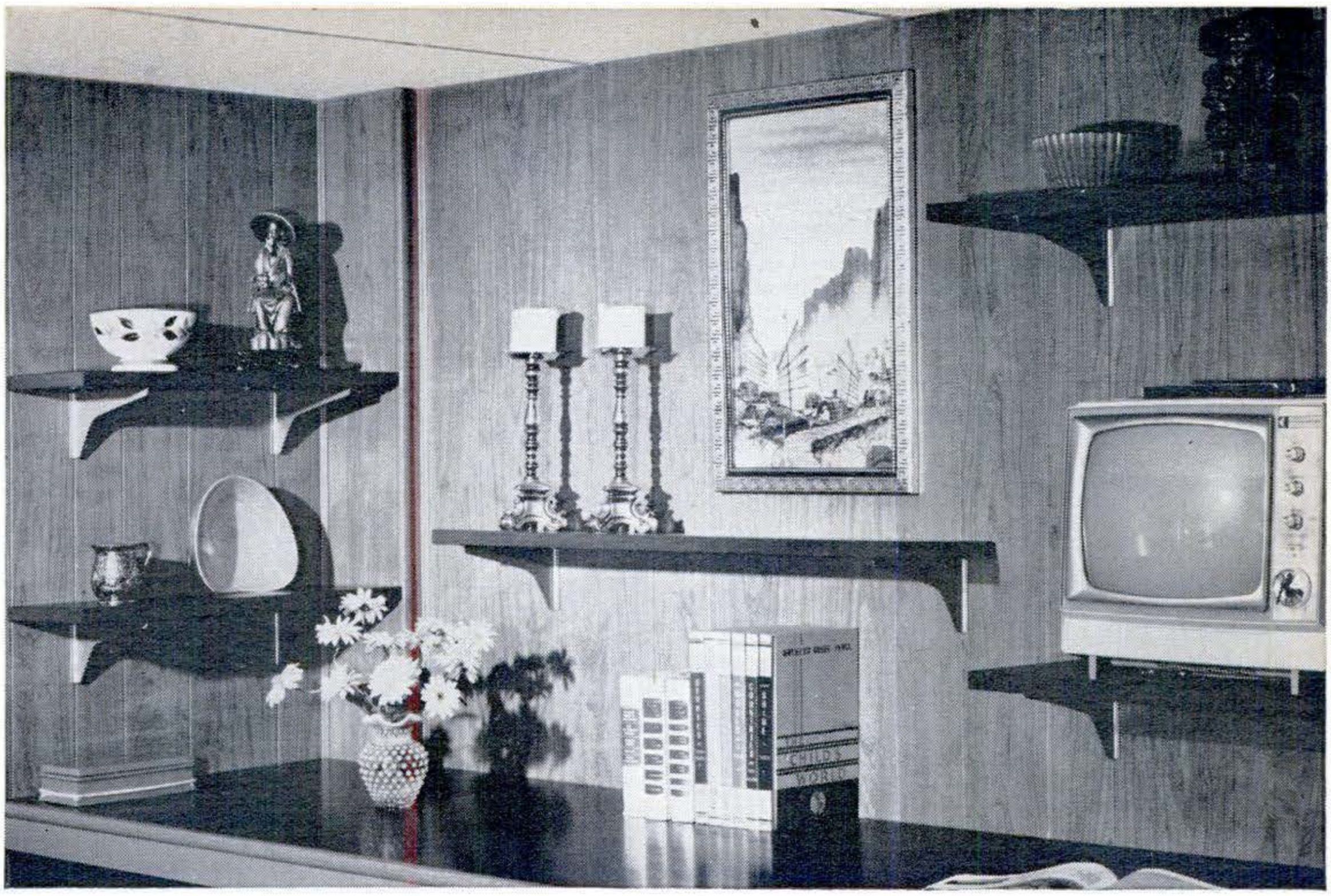

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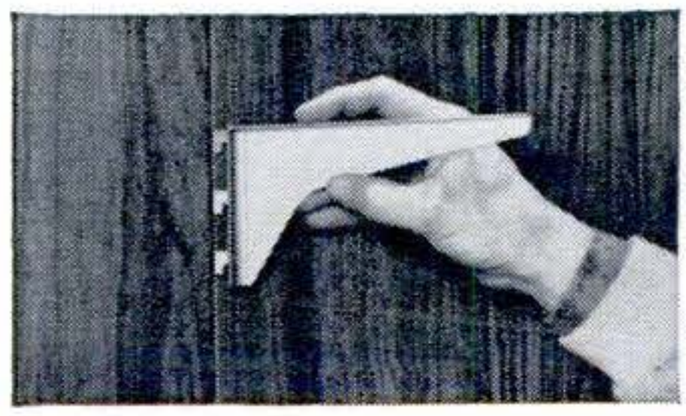

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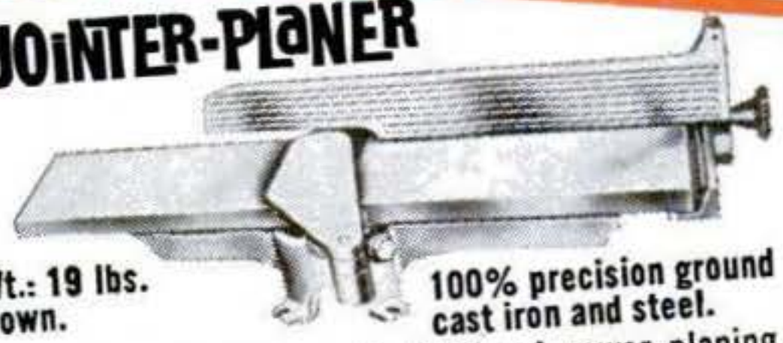

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How to get rich

How can you get rich some day? Make a hit record . . . a killing on the stock market . . . or invent a gadget like the hula hoop?

For most of us, these are just dreams. But have you ever stopped to think that there *is* a way to get rich—possibly only one sure way? Most fortunes, as you know, are made by people who own their own business.

Perhaps you've thought of starting a small business of your own . . . a franchised drive-in, or maybe a service business. Trouble is, you need $10,000 to $15,000 to get started and even then it's a gamble —with slim chance of ever making really big money.

But there is *one* business which could make you rich—almost overnight. And the beauty of it is, you can start on a shoestring during your spare time, even while holding your regular job.

Cash by Mail

The business is Mail Order—and it's fabulous! Come up with a 'hot' new item . . . and WHAM!

It strikes like a bolt of lightning!

Suddenly, you are deluged with cash orders from all over the country . . . MORE MONEY than you could ever make in a lifetime!

Like the Vermont dealer who ran one ad in Sports Afield Magazine. His ad pulled 22,000 orders—over A HALF MILLION DOLLARS IN CASH!

There is no other business where you can make a fortune so quickly!

- A beginner from Newark, N.J. ran his first small ad in House Beautiful—offering an auto clothes rack. Business Week reported that his ad brought in $5,000 in orders. By the end of his first year in Mail Order, he had grossed over $100,000!
- Another beginner—a lawyer from the midwest, sold an idea by mail to fishermen. Specialty Salesman Magazine reveals, "he made $70,000 the first three months!"

Proof

It's a fascinating business! Running ads in newspapers and magazines . . . mailing gift catalogs . . . getting cash orders in your daily mail—steady as clockwork.

There is no other business where you can start on a shoestring and pyramid your profits—*without investing in merchandise!* One husband and wife mail order team took in $40,000 selling one item. They obtained FREE ads in national magazines . . . didn't invest a cent in merchandise, and even got the supplier to ship all orders for them!

These exceptional cases are absolute proof that *you can get rich* in your own Mail Order business. Very rich. Even a U.S. Gov. Report stated: "A number of one-man Mail Order enterprises make up to $50,000!"

Pick up any magazine. Notice how the same mail order ads are repeated . . . month after month? That's concrete proof! You know those ads wouldn't be repeated over and over again—*unless* they were bringing in big cash profits to their owners.

The Secret

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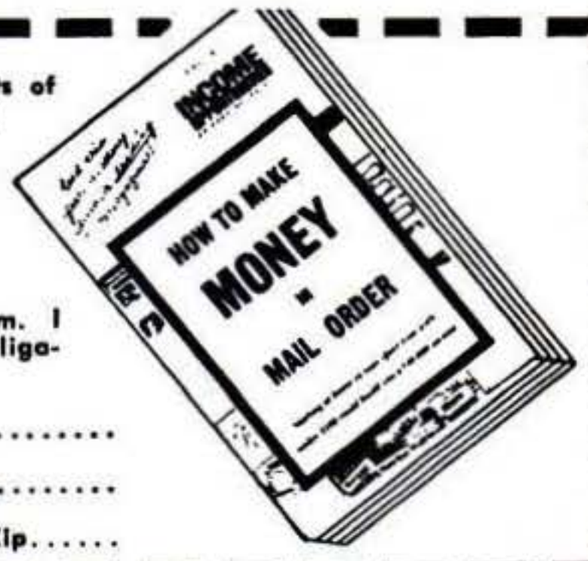

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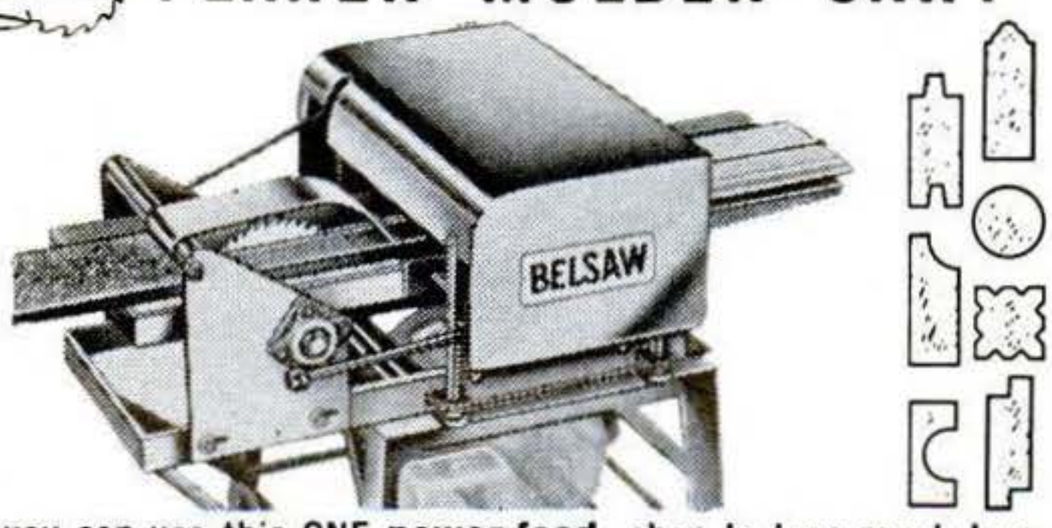

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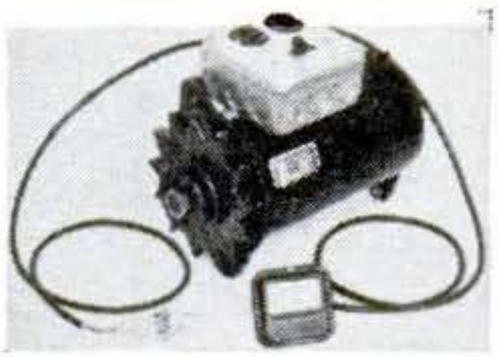

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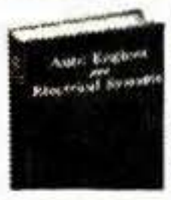

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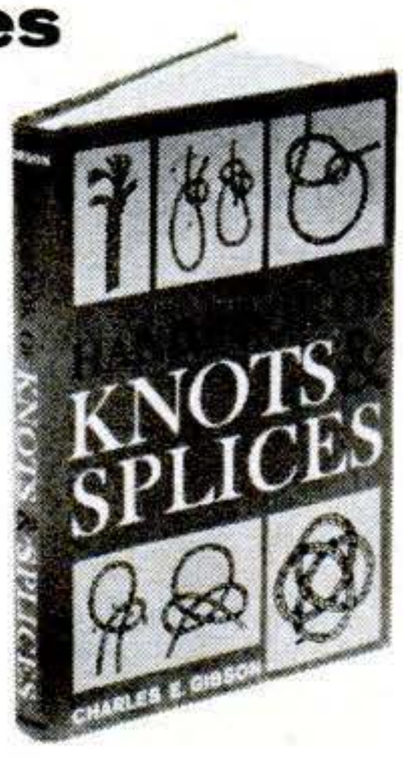

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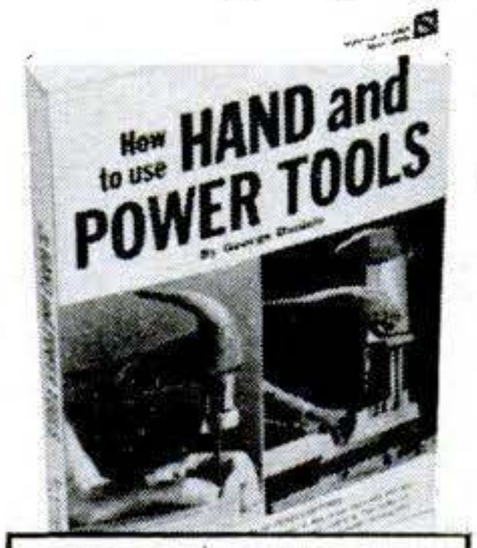

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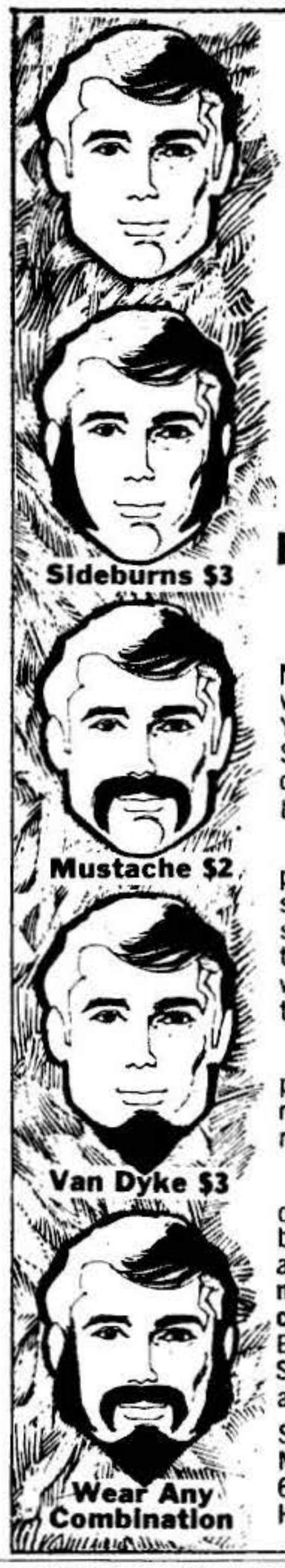

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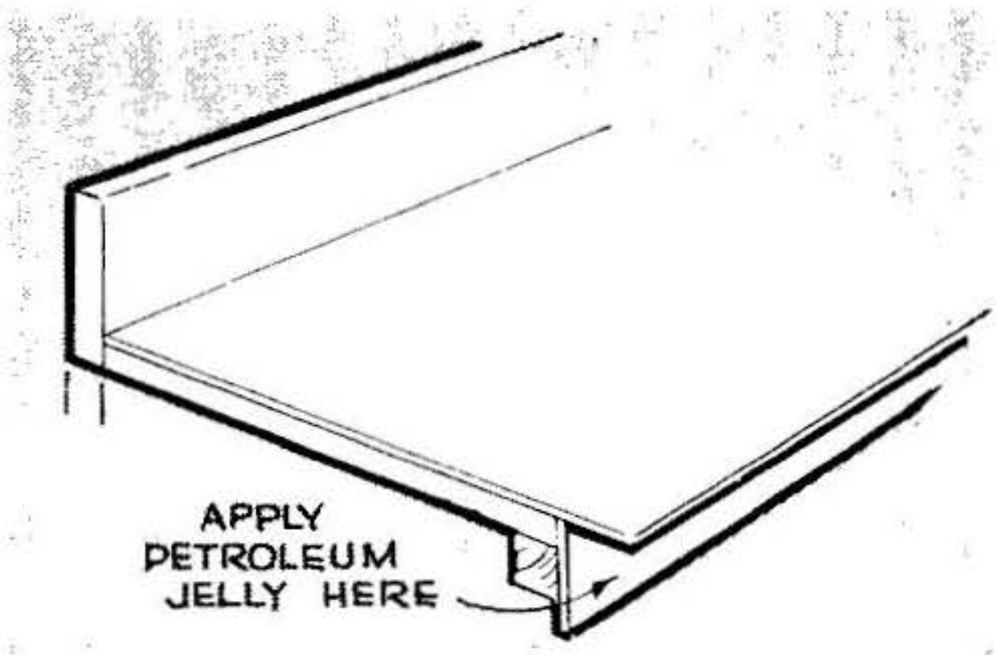
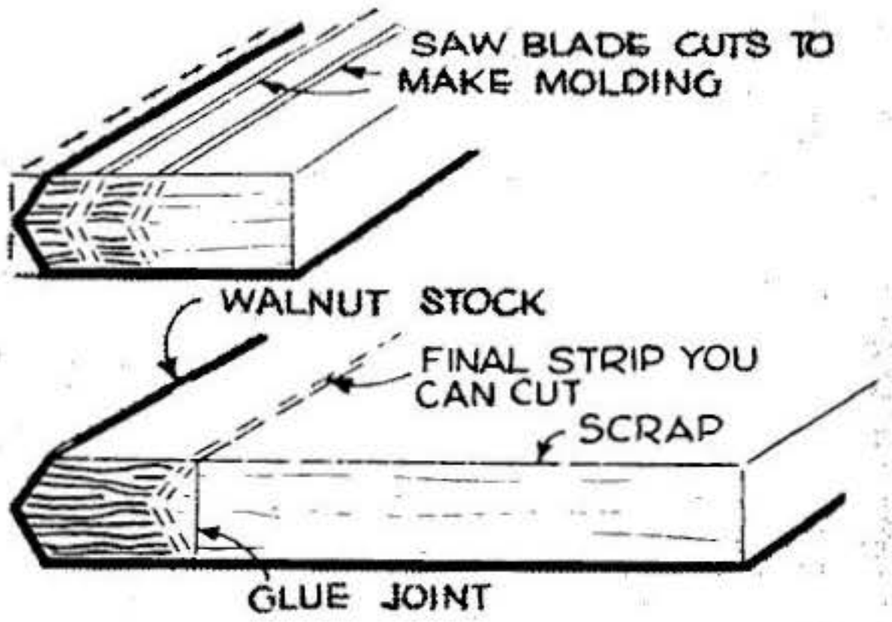


Easy way to stop router burn

When you're using a router to trim a laminate counter top, friction heat can cause the router to scorch the self-edge. I have found that by applying a thin coating of petroleum jelly to the face of the self-edge, you can eliminate this burning problem.

J. GAYNOR, Seaford, N.Y.



Gluing stretches the molding

When costly hardwood stock from which you're cutting moldings becomes too narrow to cut safely, glue it edgewise to a piece of scrap wood the same length and thickness. When the glue dries, more strips can be cut from the stock safely.

ABRAHAM KOBLIN, Baltimore, Md.

Thin paper prevents file damage

The face plate of a new lathe was damaged in shipping. I removed the welts and burrs without touching the undamaged surface by placing a sheet of onionskin paper over the part and using a smooth mill file in ½-inch strokes. By applying pressure only over the damaged area, the file cut through the paper at only the high spots.

D. M. MILLER, Sunnyside, Wash.

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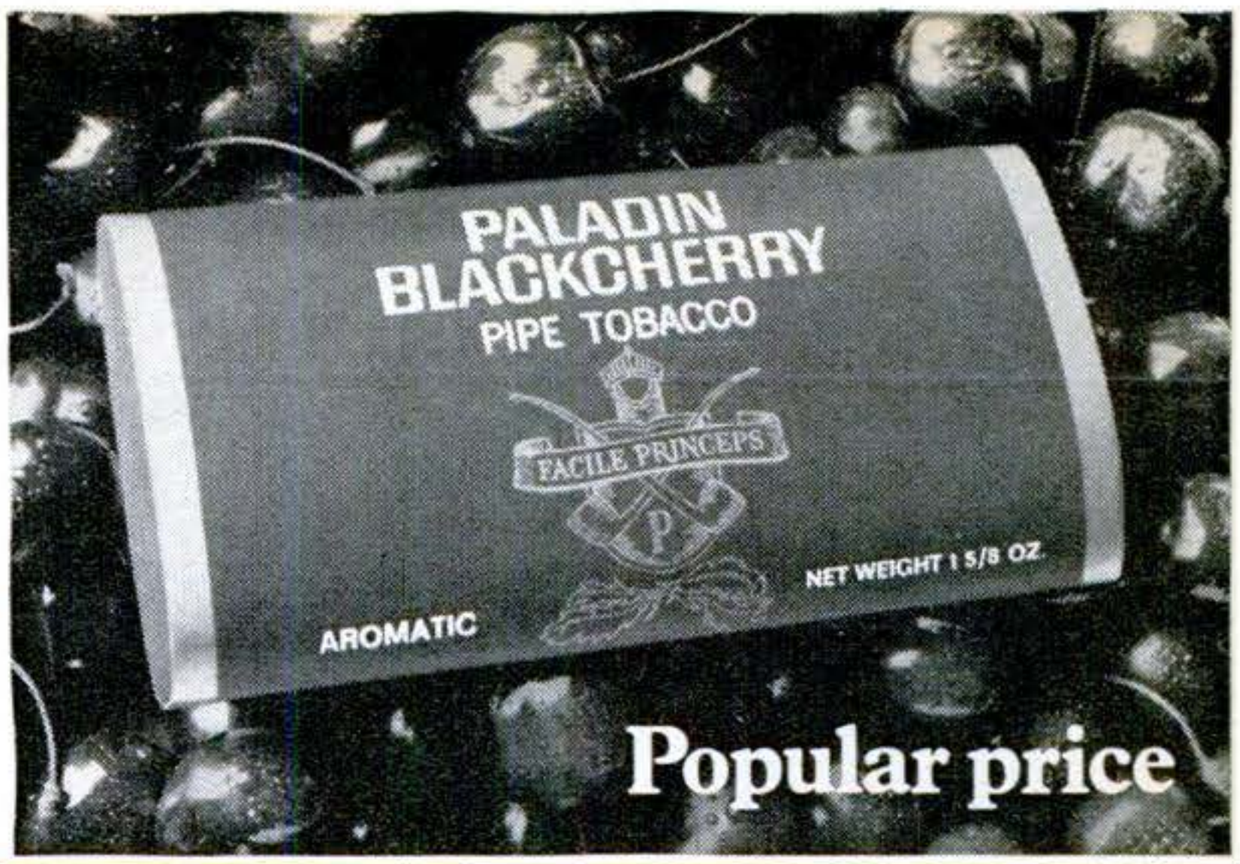

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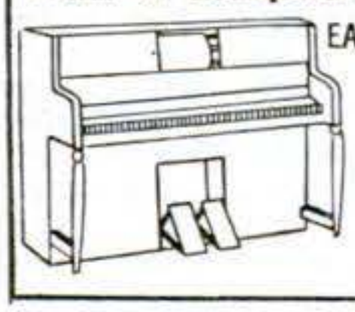

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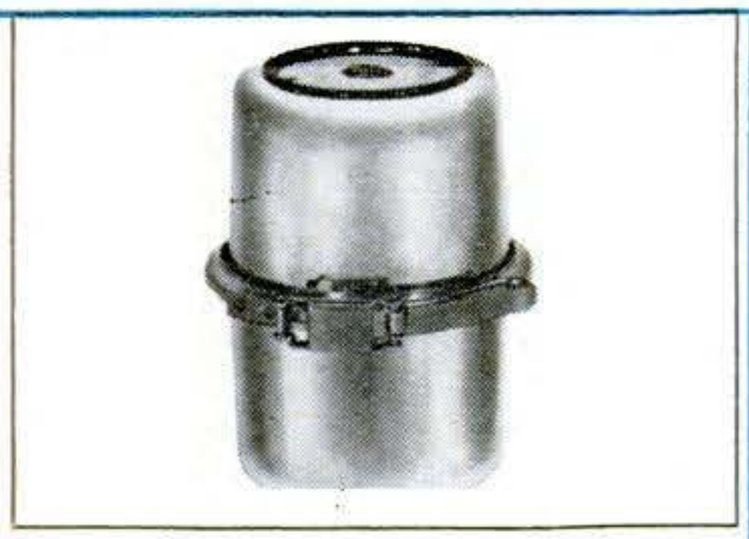

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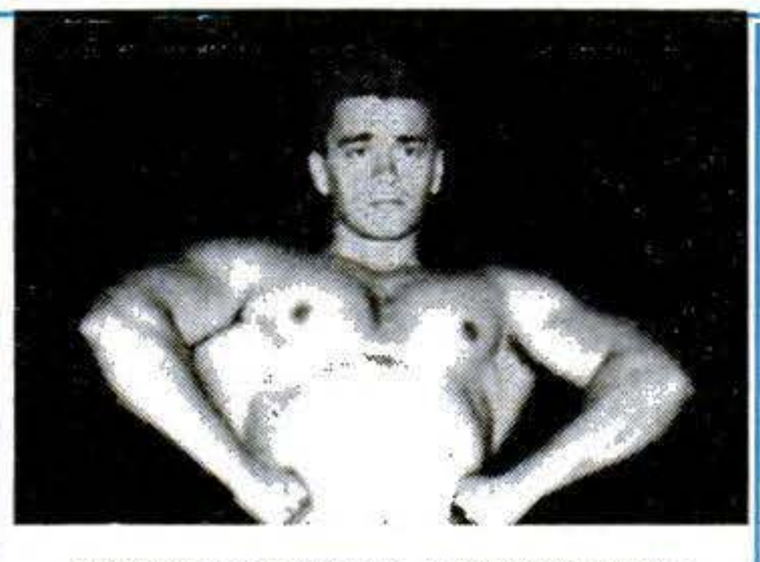

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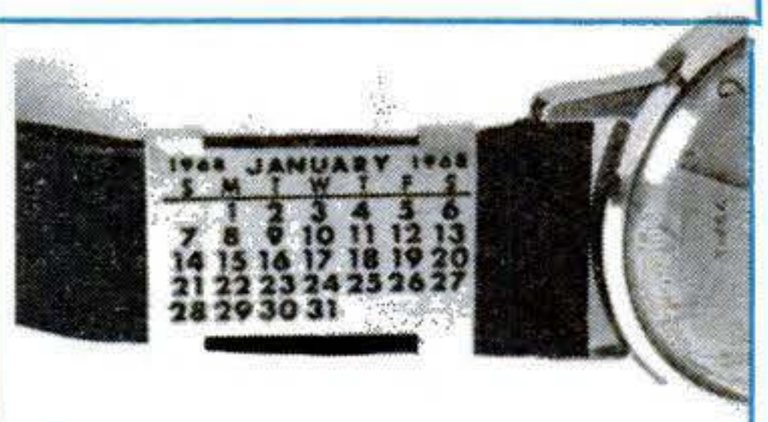

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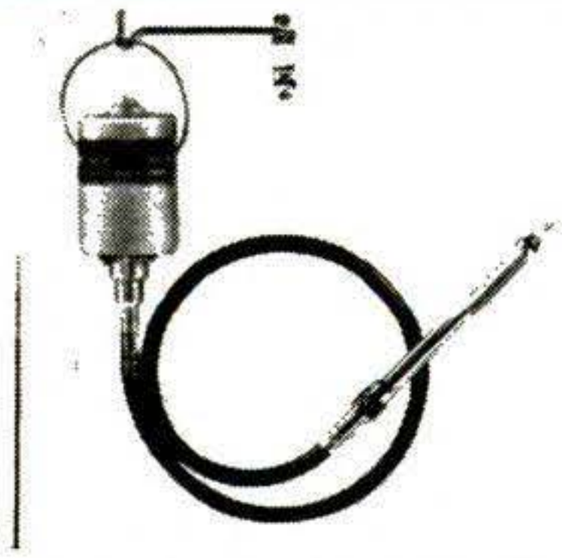

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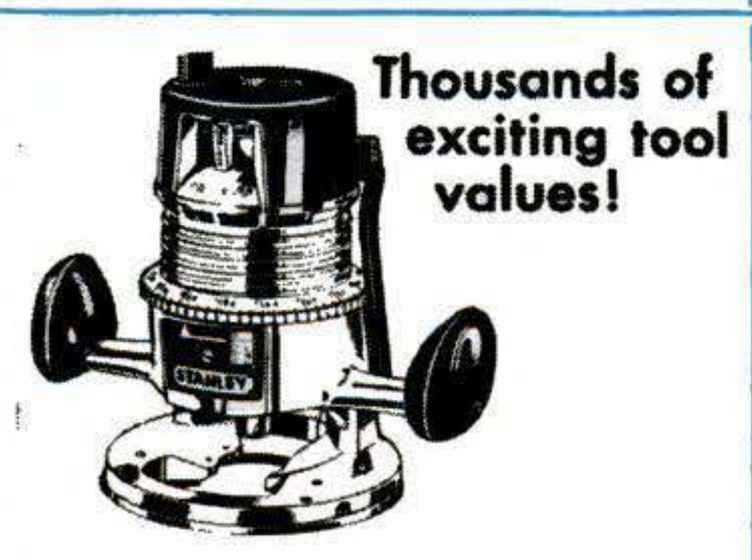

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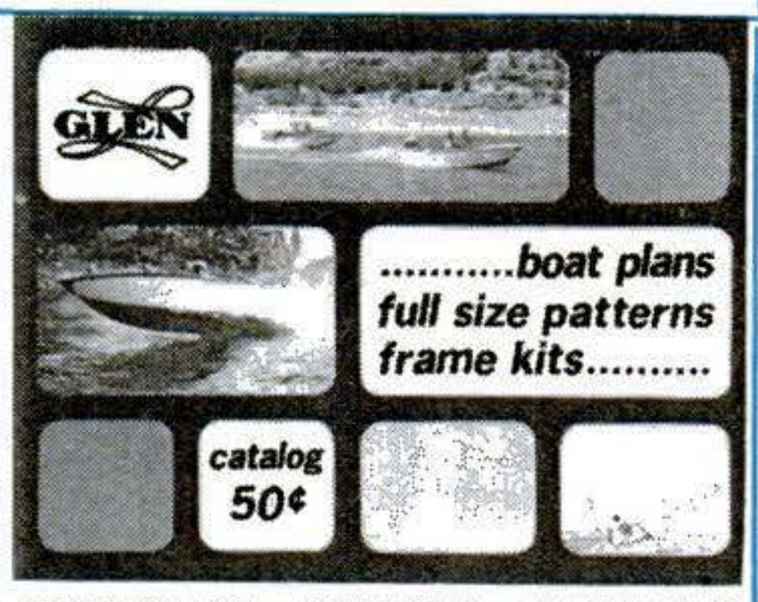

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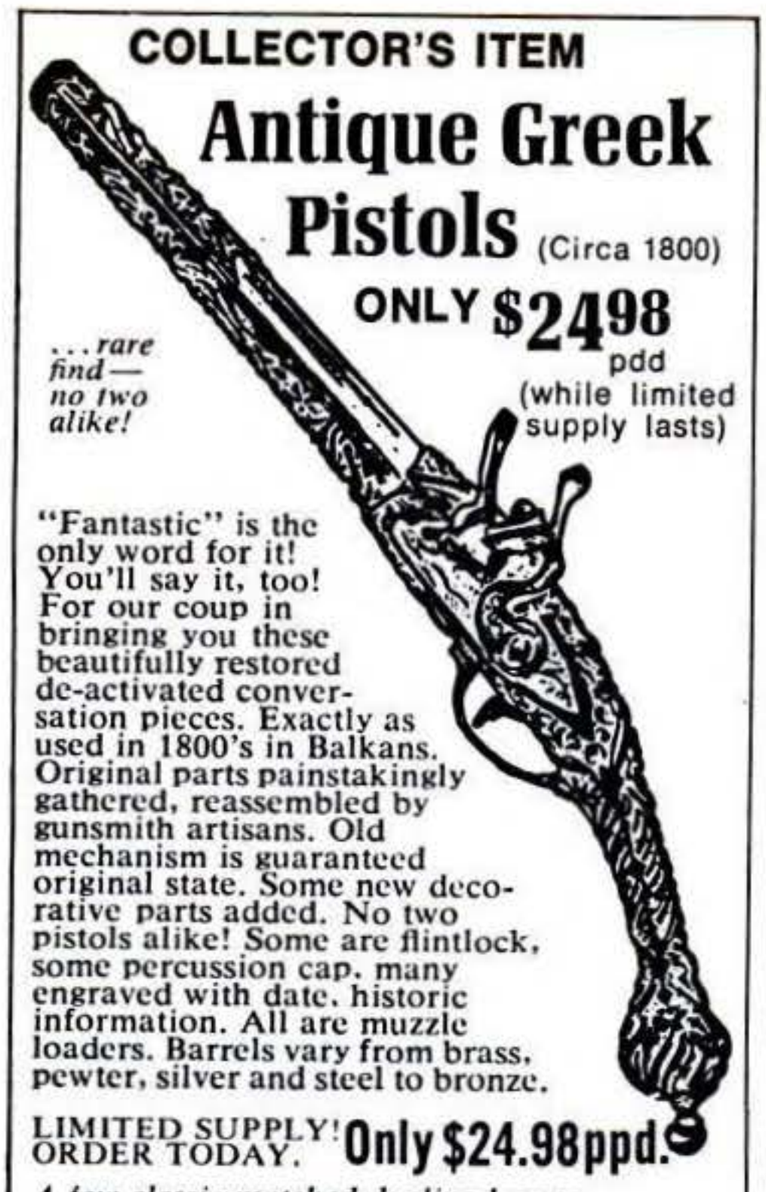

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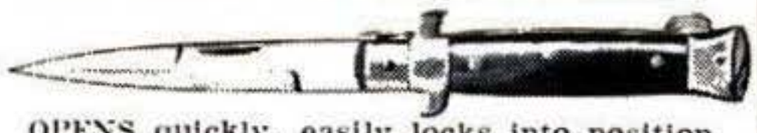

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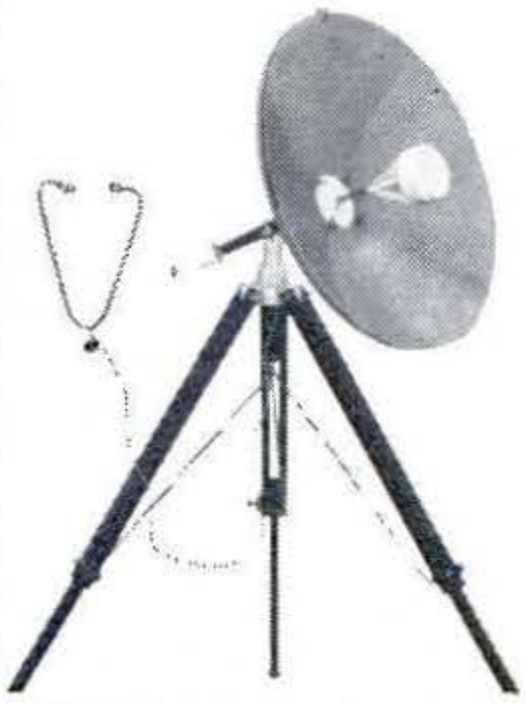

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Detroit Report...

HUSH-HUSH WORK AT PONTIAC is centered around a tiny commuter car. The power unit is a four-cylinder air-cooled radial engine positioned ahead of the rear wheels. The body holds three passengers in its single bench seat, and appears much shorter than a Volkswagen. Insiders hint that a model could be in production within 30 months. Whether Pontiac is serious about producing the car or not, General Motors is spending a lot of money on a study of commuter-car design.

Chevrolet's all-new G-body car—to be introduced next fall—will definitely have single headlights as a styling touch to make it stand out from competitors (Thunderbird, Grand Prix). This car, dubbed Chaparral, is built on an extended Chevelle chassis and has a wheelbase of about 117 inches. It is a luxury-appointed personal car that seats four passengers. At first glimpse, it resembles the early Chevelles, having the same squarish appearance and fender highlight lines, and—head-on—the present Impalas.

Chrysler's plans for 1970 hold some surprises. Dodge's Challenger sporty car will appear along with a newly styled, but not spectacular, Barracuda. Plans in effect now will have the Challenger replace the Dodge Charger completely during 1970. This proposal runs counter to the industry trend to build more personal cars in the model-size slot Charger now occupies. Pontiac's Grand Prix, Chevrolet's new car, and later the Ford Thunderbird, will be built on intermediate-size chassis.

Pontiac's 1970 GTO has a new front end that is simply a larger version of the current Firebird grille—with one important exception: The entire bumper is made of Endura rubber, not just the extensions surrounding the headlights. Like all GM intermediates, the new GTO will have an all-new body next year. The big Pontiacs will get the Grand Prix front styling with headlights set in at either side of a central grille opening.

"GM always skips a model year when the sales are soft," commented one competitor who talked about the 1970 Camaro. The car will get a completely new look next fall after only one year with the present body. "It isn't gaining on Mustang, so they'll try to spark it up," said the competitor. Whatever Chevrolet's reasons for the early change, the 1970 Camaro should give Mustang a run for the money. It looks like a miniature Eldorado even though it has single headlights and a blade-thin front bumper. Sporty models carry a wide, flat hood scoop. To top off the Camaro line, Chevy is planning a sleek fastback model for introduction later in the 1970 model year. This car will attempt to put a dent in Mustang's fastback sales, which are running over 37 percent of Mustang's total.

THE GM XP 887 subcompact has not yet reached its final design. One GM insider says the proposed styling of the XP 887 was junked in late 1968, and a new design started. The original plans made it look too much like other little cars now on the road. A Ford source says GM is now concentrating on a bigger car, about the same size as Ford's Maverick, and this car may come earlier than the XP 887. GM is shifting its focus to a bigger small car, that will delay the XP 887. One thing is certain: Both GM and Ford are developing two small cars for public introduction within the next two years.

American Motors will equip some of its 1970 models with a new-type windshield that has been called the biggest advance in safety design since windshields were first laminated. Glass in the windshield is the same type used in U.S. space vehicles. In accidents, the new windshield has more "give," and breaks up into small granules instead of shards. AM will make the 1970 Javelin and AMX with the new windshields as standard equipment, later spreading the glass to the rest of the AM model lineup.

Jim Dunne

Detroit Editor

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It all started with the hot-selling Dodge compact van. Big, Tough. And ready. And now, by popular demand, its versatility has been expanded to 20 models. Included are 18 Job-Mated units (like the one shown below), outfitted to handle the needs of just about any trade. And this year you can order your Dodge van with air conditioning, power steering or automatic transmission. Only Dodge offers power steering on compacts. More examples of Dodge being first with the most.

Add to these, two revolutionary new Custom Sportsman wagons: the Executive Suite (above), a traveling office, and the Host Wagon, a basic party and play unit that can be adapted to almost any purpose.

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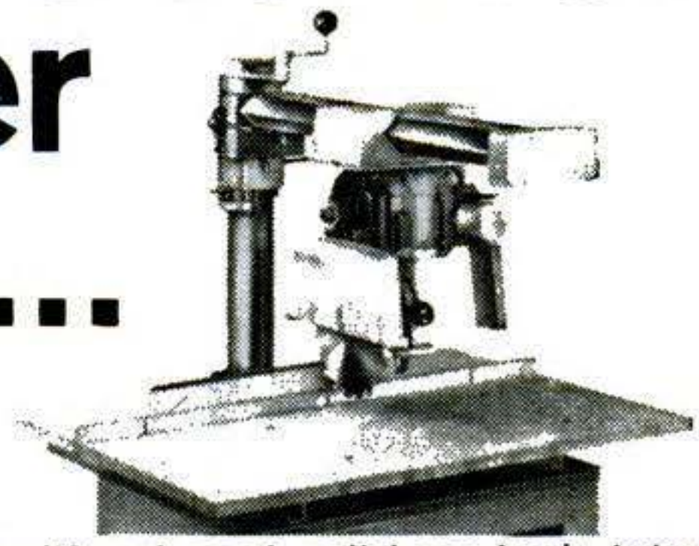

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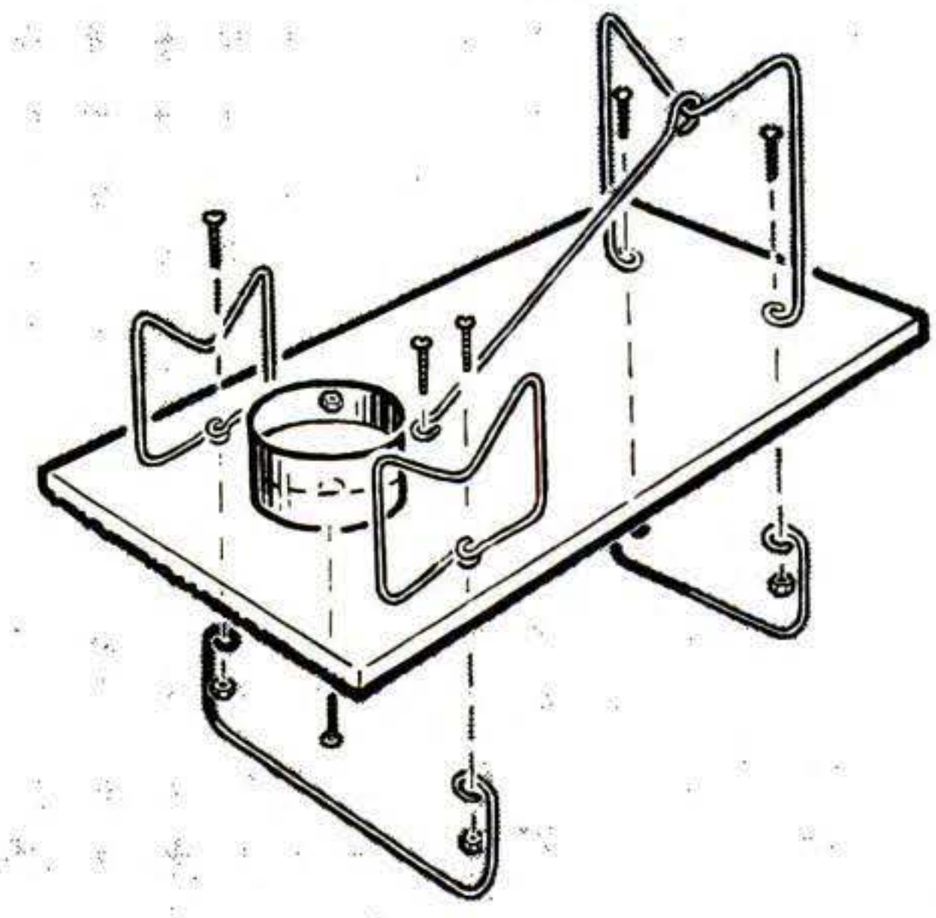
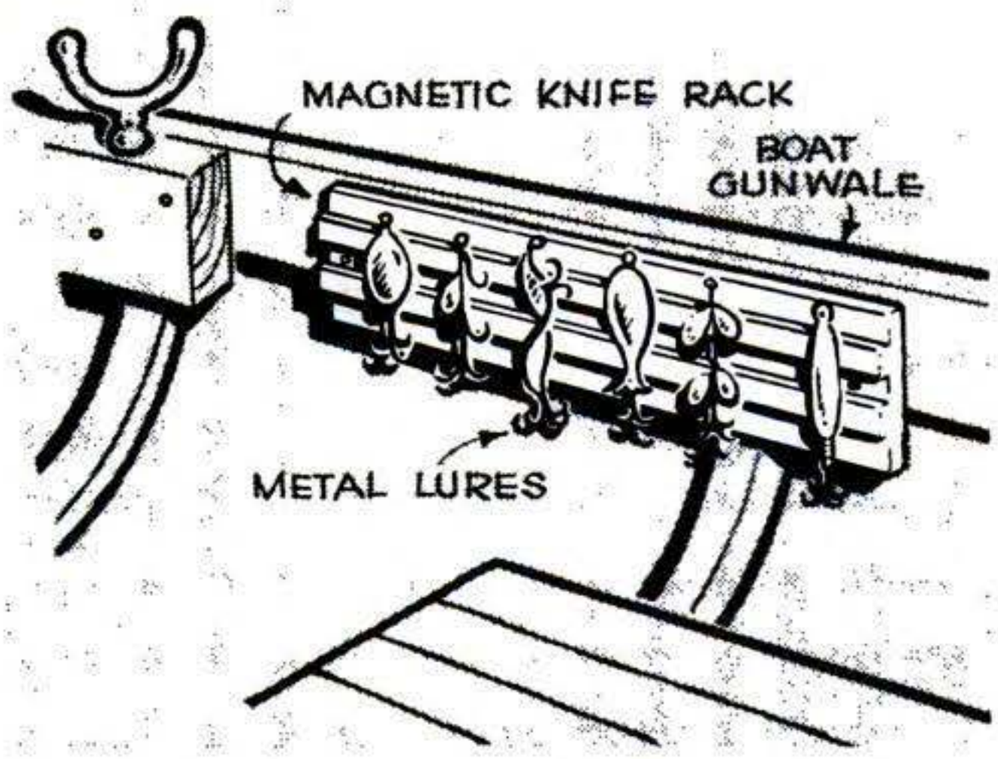


Need a soldering-iron stand?

Make this handy soldering-iron stand from coat hangers, an asbestos shingle, and part of a tin can. On long jobs, rest the tip of the iron in ¼ inch of solder in the can to keep the tip tinned and the iron from getting too hot. On short jobs, lay the iron across the low holders and it will heat up for you quickly.

CHARLES HABERMAN, Yonkers, N.Y.



Magnetic rack for fishermen

A good way to keep your metal fishing lures at hand is to attach a household magnetic knife holder to the gunwale of your boat and stick them on it. You can then easily reach for your favorite plugs and spoons, and other metallic objects, without rummaging through your tackle box or spilling stuff around.

VICTOR LAMOY, Upper Jay, N.Y.

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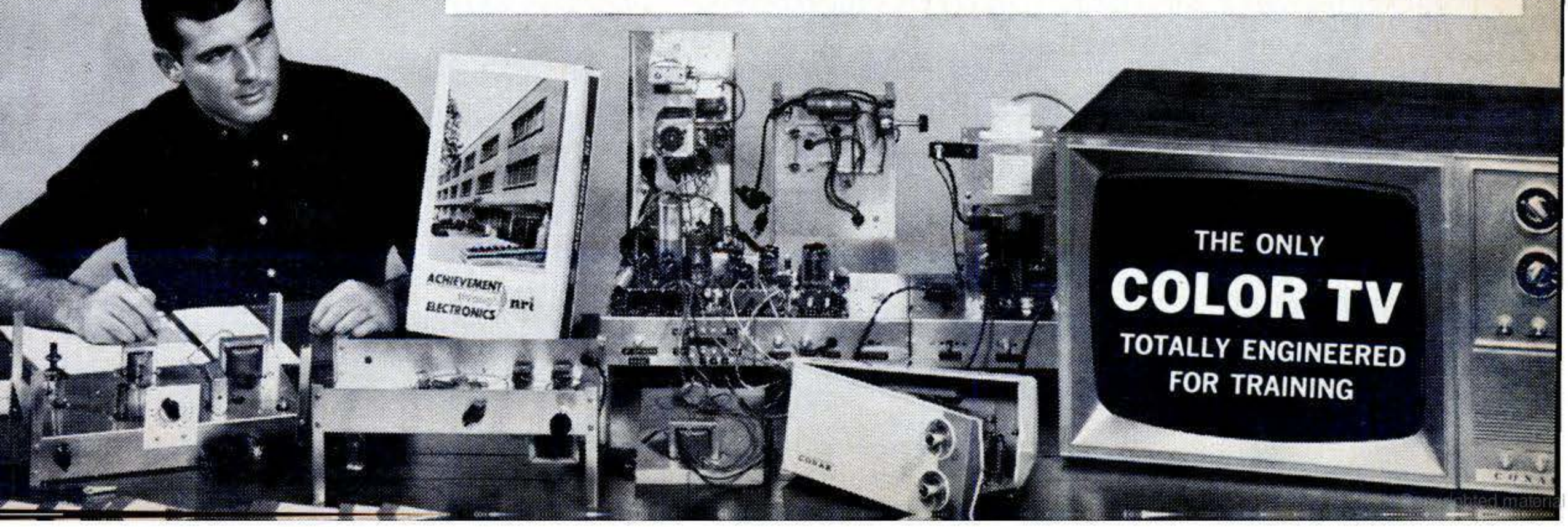

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Johnson's V-115 is lower, leaner, lighter than other motors in its hp class—makes your boat look, ride and handle better. New high in performance, new lows in fuel consumption, vibration and sound. Computer-designed lower unit reduces drag.

Our "total performer"—the new Johnson Sea-Horse 25. Fast it is, but heavy it isn't.

You can ski it, fish, cruise it, race, work it . . . and *still lift it!* New computer designed prop, large bore carb, stainless steel reed valves, new pistons with super-slim, high rpm rings are a few reasons why we've clocked it at 30-plus mph on a 14-footer.

All new Sea-Horse 4 feels like a 5. Weedless Angle-Matic

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Choose from 16 models (1½ to 115-hp) all new or improved... all with the dependability we never stop improving. Backed by our 2-yr. warranty.*

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*For 24 months after purchase, Johnson Motors will replace or repair without cost to the original purchaser any part of its manufacture which, upon inspection, proves to have failed in normal pleasure use due to faulty material or workmanship.

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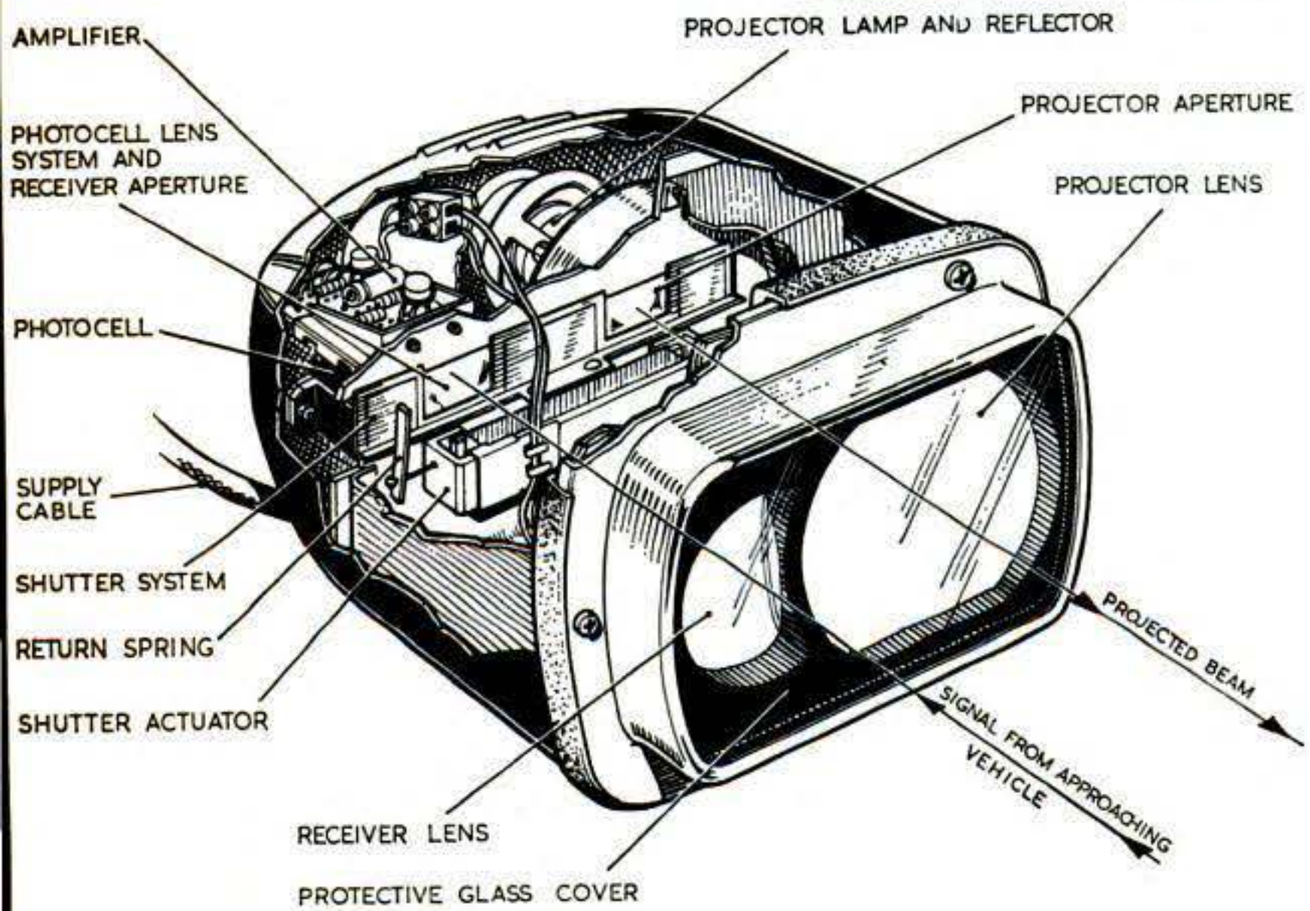
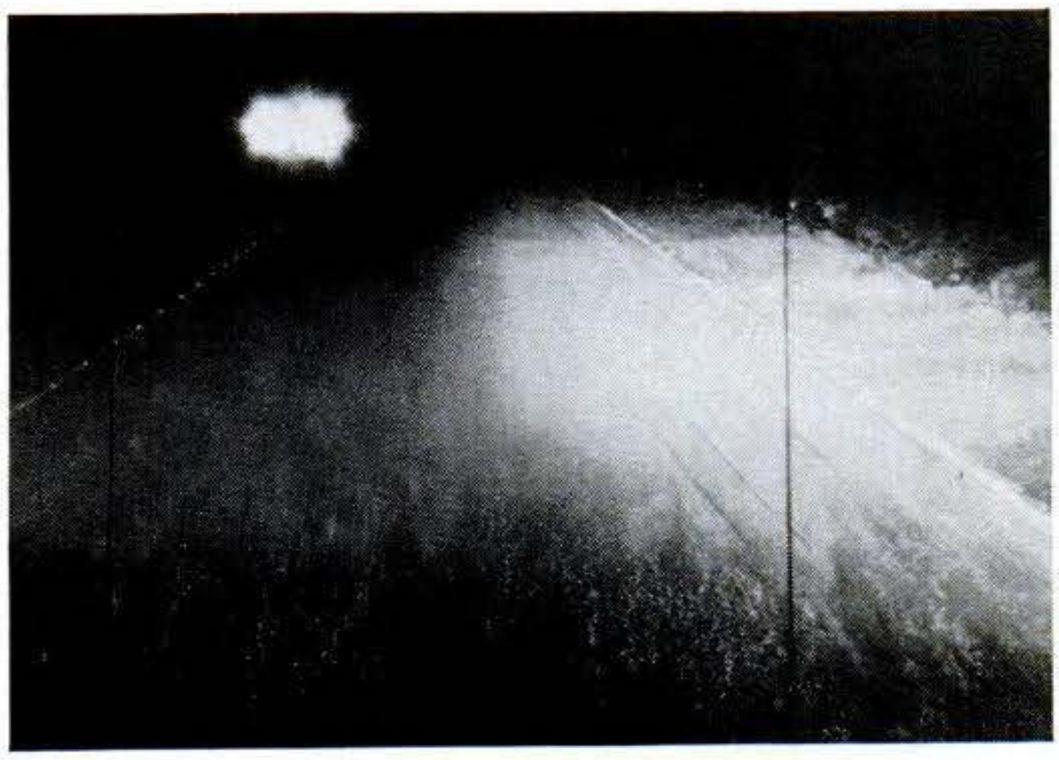
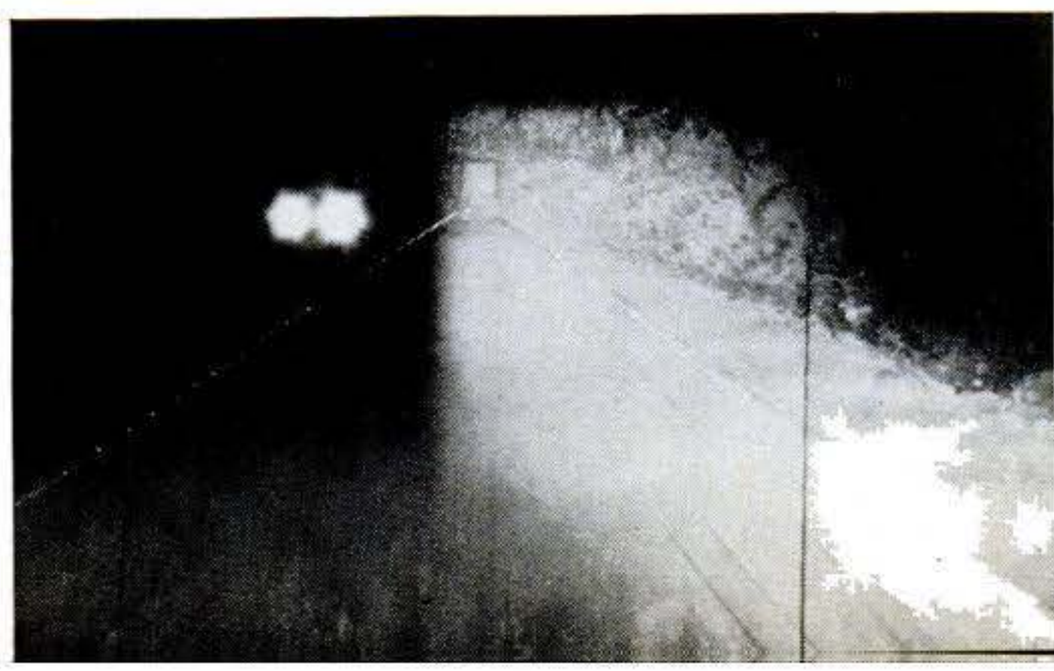


Photocell receives signal from an approaching car and moves shutter to prevent eye-dazzling glare.





New Long-Reach Headlights Have Automatic Antidazzle Shutter

An amazing new self-aiming headlight doubles the seeing distance ahead with low-beam illumination without blinding approaching drivers. Made in England by Lucas, the "Autosensa" combines a photocell receiver with a high-intensity quartz-iodine light.

When the beam from an oncoming car hits the cell, the minute current is amplified to energize a linear actuator that moves an internal sliding shutter into the path of the projected beam. This provides a sharp vertical cutoff along the left edge of the beam, blacking out any light that might shine on the other car.

At the same time, your side of the road is brightly lighted up for about 400 feet —just double the distance for conventional sealed-beam lights on low beam.

As soon as the oncoming car has passed you, the actuator is de-energized and the light spread returns to normal. The Autosensa also operates behind tail lights up to a distance of 200 feet, diverting the beam to prevent mirror-dazzle ahead.

Used in a four-headlight array, two units are wired to the dipped-beam circuit of your car's regular outer lights. There is an over-ride switch to cut them out when desired. These lights draw more current from the battery, but there's no doubt that they're worth it.

Compare them: Ordinary low beam spreads light at top (left); Lucas cut off long-reach beam is below.

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We'd like to put in a good word for hoods.

Why not? We've got the toughest looking in the business.

Take that sweep of metal on the '69 Pontiac Grand Prix. You won't find a longer stretch from Sing Sing to Alcatraz.

The two bulges on Firebird 400 and GTO are pretty unsubtle, too. They're air scoops. Functional air scoops when you order Ram Air.

Now, you can order an externally mounted tach for each of these hoods. And they'll look tougher. But let's face it. No hood's complete without a persuader.

Pontiac has them.

Grand Prix's is a standard 350-horse, 400-cubic-inch V-8. Or specify a 370- or 390-horse 428-cube V-8.

Firebird 400 has a 330-horse, 400-cubic-inch V-8 standard. You get even more impressive statistics when you order the H.O. or Ram Air IV version.

GTO started it all. Remember? A 350-horse, 400-cubic-inch V-8 is standard. A 366-hp V-8 and a 370-hp Ram Air IV await your order.

Obviously, this is no year to go around bad-mouthing Pontiac's hoods.

GM

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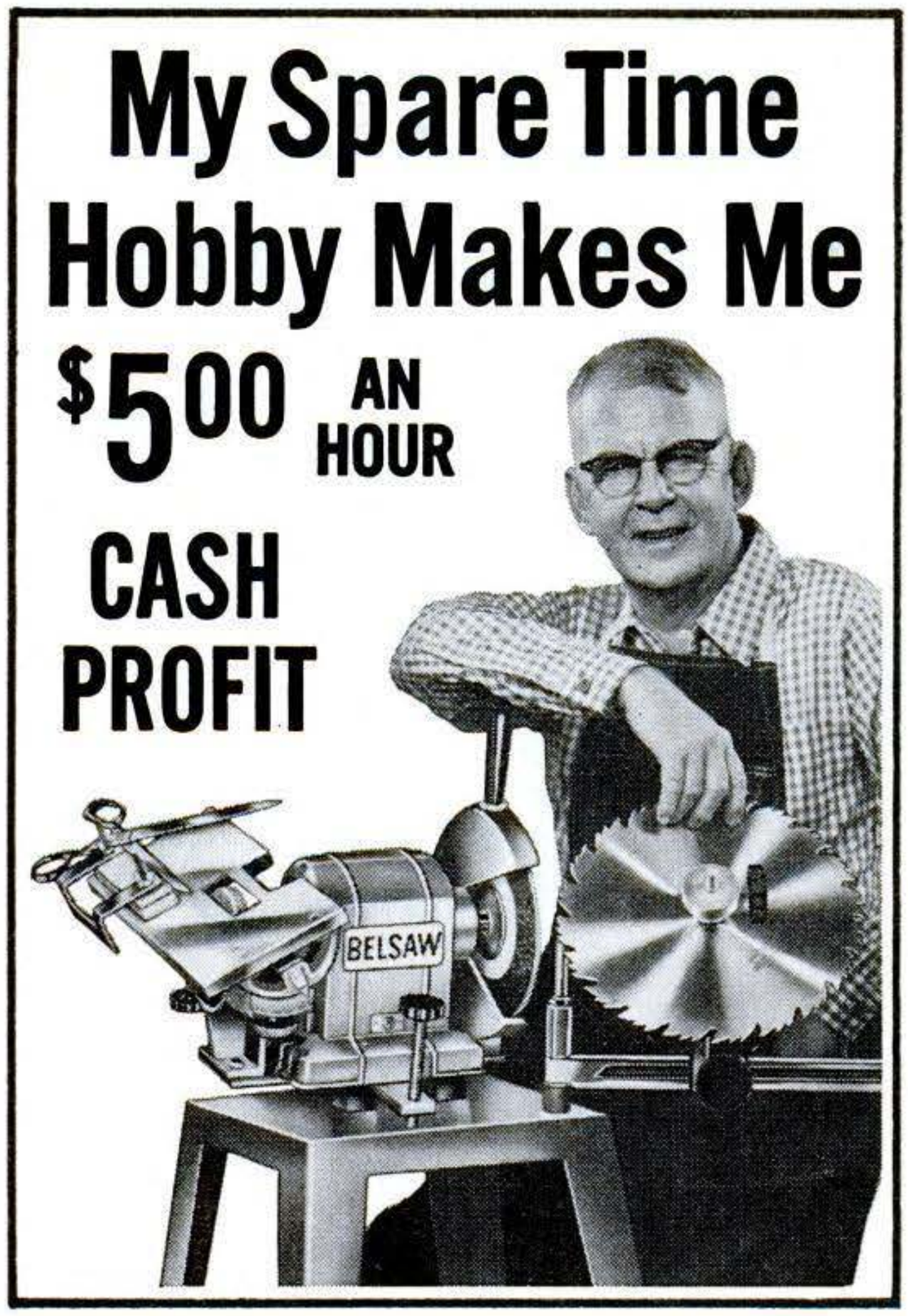

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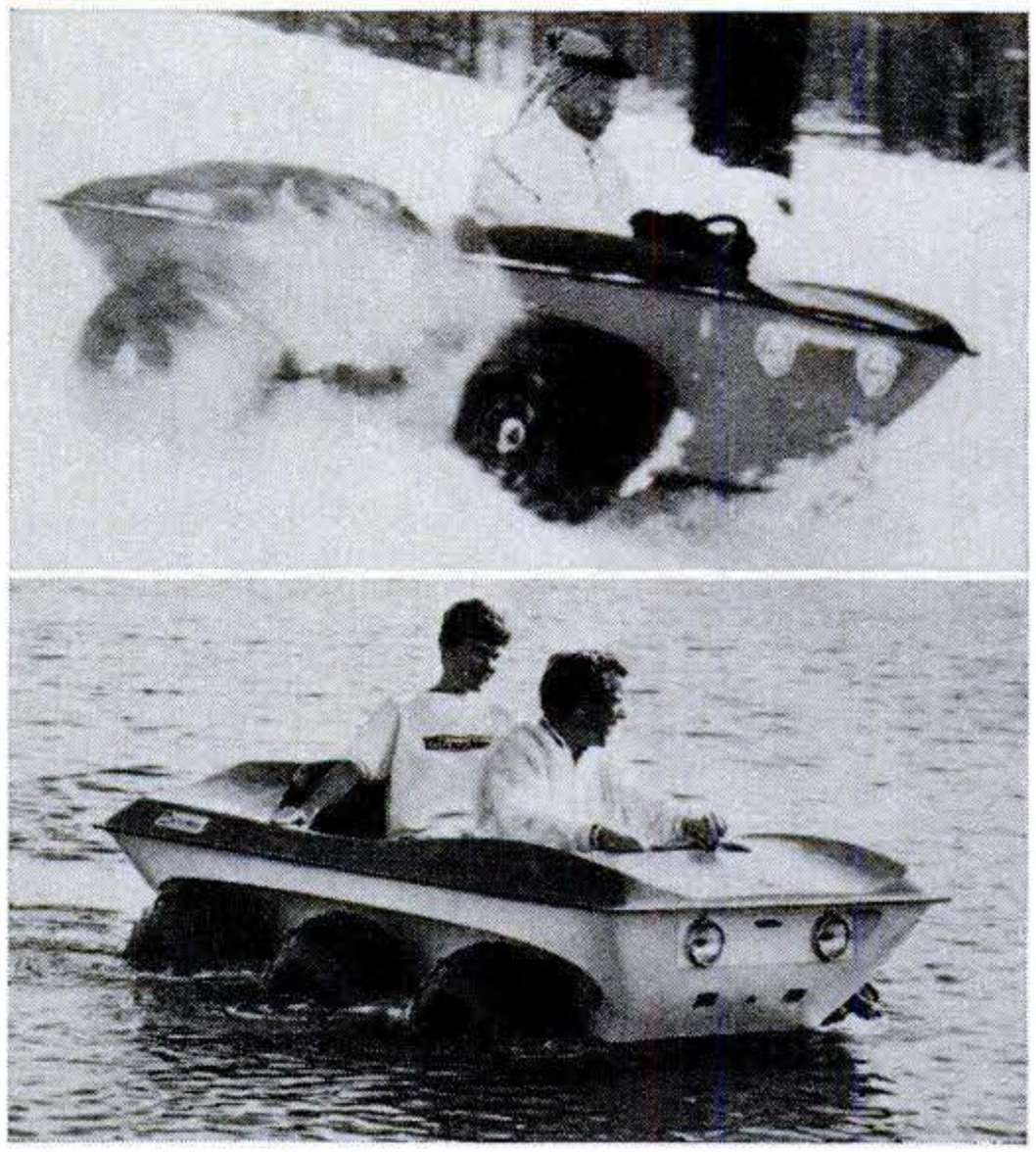
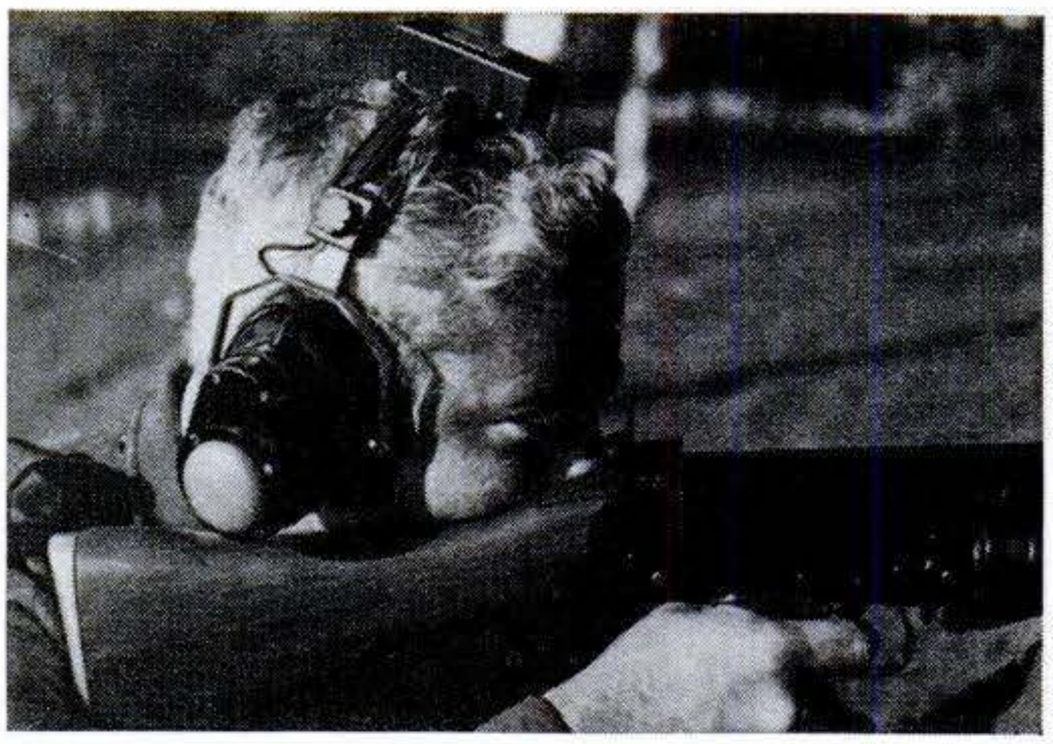


Six-wheeler turns in own length

The fiberglass Scrambler can carry three over snow, sand, or swamp, and on water. A seven-hp. engine transmits power through a variable-speed torque converter to each of six wheels, each with its own clutch and brake. To turn, the Scrambler pivots—automatically braking the wheels on the side toward the turn. Speed on land is 20 m.p.h.; in water, two m.p.h. $1,395, Action-Age, Inc., Cleveland, Ohio 44128.



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The Ear Defender Headset cuts out only noise above 95 decibels, so you can easily hear normal speech. Each earpiece has its own mike, amplifier, and speaker for normal stereophonic hearing. Liquid-filled pads seal phones against the ears. The compact unit gives free movement to shooters and workers around explosives and jet engines.

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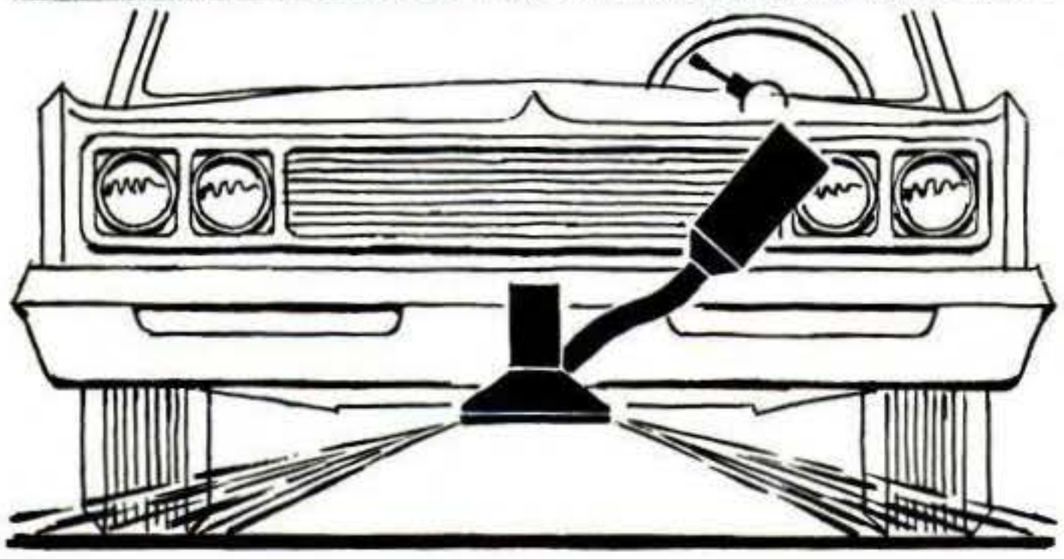

Sand spreader for slippery roads

This motor-driven sand spreader, invented by a Swiss engineer, feeds sand from a container to a conical housing below the motor. A disk on a telescopic coupling that acts like a lead-screw spreads sand in front of, and below, the car. The spreader motor is turned on with dash-mounted switch and shuts off automatically after three seconds. The reservoir holds enough sand for six to eight bursts when the going is slippery.

Giant Lectra Haul carries 200 tons

A 200-ton capacity diesel-electric dumper, the Lectra Haul M-200, above, is the world's largest single-axle truck. A 1,650-hp. diesel drives the generator that powers the wheel motors. The giant rides on 10-foot-high tires, and is used by Kaiser Coal Ltd., subsidiary of Kaiser Steel, for strip mining in Canada's British Columbia.

LGC
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Most modern hulls consist of layers of fibreglass bonded together. Flotation is provided by blocks of plastic foam and by an air chamber in the bottom. Some types of foam can become waterlogged and ineffective. And because most buoyancy is in the bottom, a boat filled with water tends to capsize.

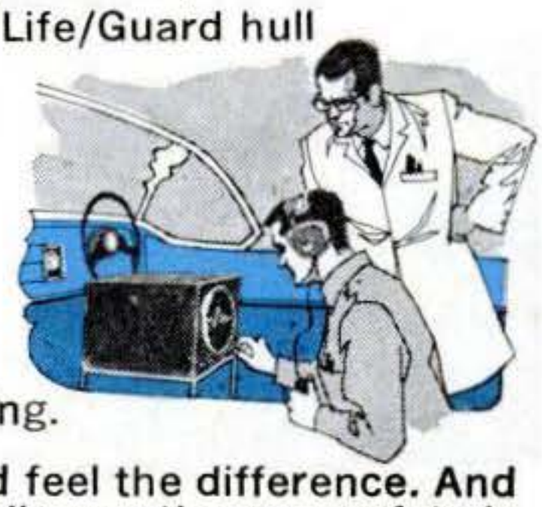
If the hull is punctured, water fills the "bilge tunnels," supplying the boat with its own ballast to keep it upright . . . while Life/Guard Construction keeps it from sinking.

Here's how Life/Guard Construction is different: a new kind of foaming plastic becomes an integral part of the boat. It soaks up sound and vibration but can't soak up water.

It's safer because the foaming plastic can't become waterlogged. The boat is constructed with most flotation high in the hull and under the deck. This fact, combined with the "bilge tunnel" makes it virtually impossible for a boat filled with water to "belly up"—it remains right side up.

It's stronger because the Life/Guard hull is an integrated unit of layers of fibreglass, foam which adds structural strength, and additional layers of fibreglass.

It's quieter because the foam deadens water and engine noise instead of transmitting and amplifying.



You can actually hear and feel the difference. And the quieter, softer ride tells you the new safety is there. Some day, other boats will be built this better way. Today it's available *only* in Larson and Glasspar Boats.

Life/Guard Construction is another innovation from a company with a 54-year tradition of innovation—the world's largest builder of fibreglass runabouts.

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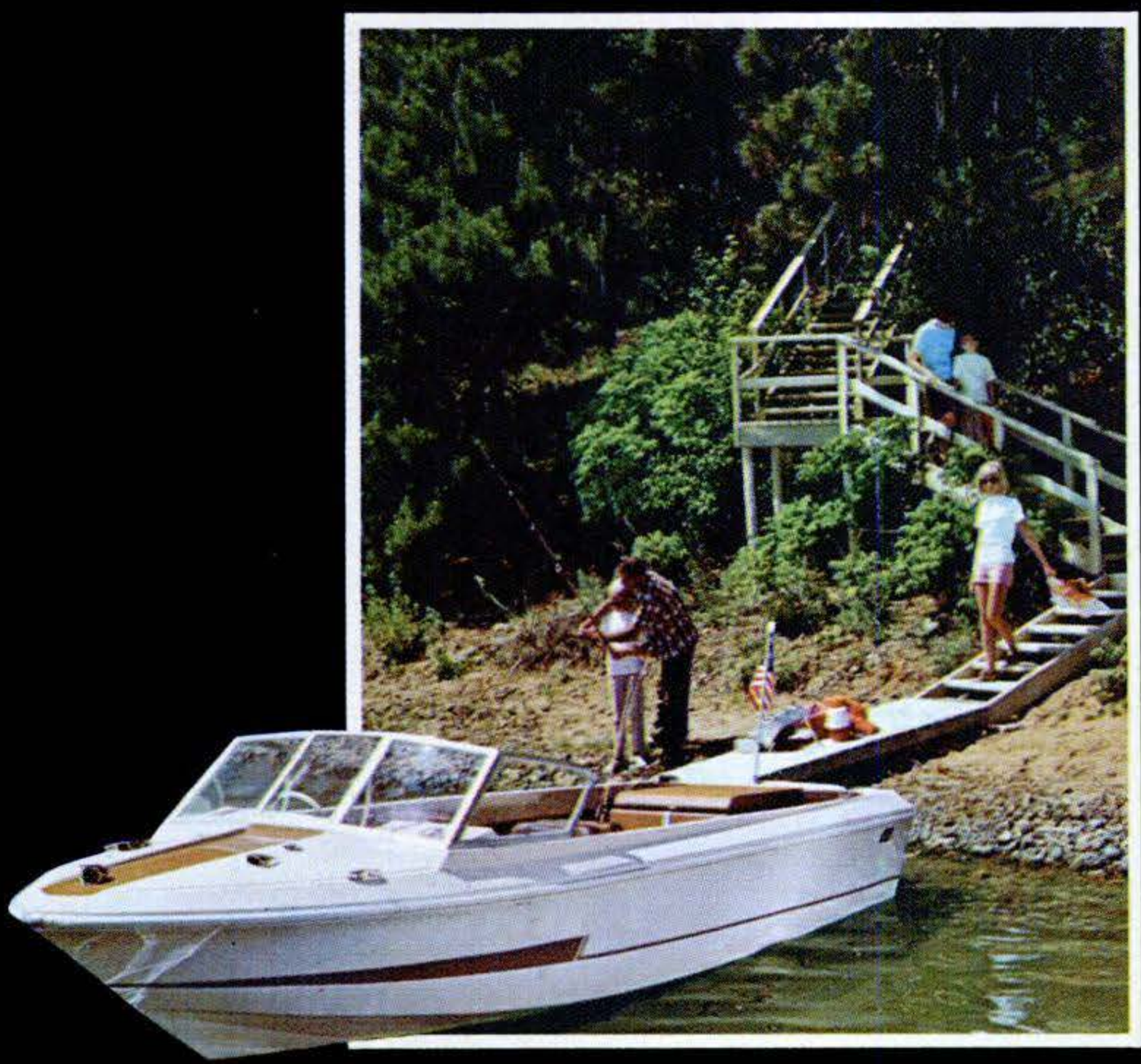

Skin deep

(under the beautiful skin is strong, silent Life/Guard)

The '69 Larson is no *fragile* beauty. Because inside, she's a completely new kind of boat—stronger, safer, quieter. Life/Guard Construction* is the reason.

Life/Guard makes flotation foam provide more safety—and more than just safety.

The buoyancy is concentrated high in the hull, so even if you fill a Larson with water, it floats right-side-up. Most boats don't. Providing the buoyancy is a new kind of foam that can't absorb water. Permanent safety.

The foam is applied in a new way, too. It's formed in-place between the inside and outside layers of fibreglass. It makes the hull stronger. And it absorbs engine and wave noise most hulls transmit.

If Larson's pretty skin isn't enough to convince you, look deep. Look at the handsome interior, with vinyl reclining sunbather seats; the four exciting color schemes to choose from. Consider all the unextras (extra-cost accessories in other boats) and the lapline hull's soft million-bubble ride. And think about Life/Guard peace of mind.

No wonder more people buy Larsons than any other fibreglass runabouts.

*Patent Applied for.

Larson®

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Evinrude 115-S
115 hp V-4
THE "SNUGGER"
world's smallest big outboard!

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Evinrude announces a major reduction in outboard motor size

Outboard motors are big enough.

The real trick is to make them *small* enough. Small enough and *short* enough to get the power package back down in the motor well — where it belongs.

How we did it is a story straight out of outer space: Space Age materials. Solid state electronics. Computerized design. Miniaturization. And the low-silhouette V-4 shape. This new second-generation Evinrude V-4 is so far advanced mechanically, we literally had to teach machines to build it.

We made the big outboard *better* by making it smaller.

The action's all there — everything from competition speeds to the highest take-off power of any Evinrude ever built. 115 horsepower in 37% less space and 20 lbs. less weight than last year's compact Evinrude "100".

And the weight is concentrated down *low* — for *safety* and *stability*.

The push-button luxury is there, too — with fail-safe electric shifting, sound-sealed quieting and all the inconspicuous elegance of an inboard or stern drive — at hundreds of dollars less.

All that's missing is the height, and the bulk, and the size. We'll gladly leave these things for whoever wants to claim the "biggest outboard".

We don't.

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Miller makes it right

We've always thought it a good idea to put our beer in the same clear glass you do.

Next time you have a beer, make it Miller High Life. You'll know what we mean when we say: Miller makes it right. And that's why it is The Champagne of Bottle Beer.

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EXCLUSIVE!

How We Film Under the Sea

Amazing one-man subs bring you eye-dazzling pictures from the deep

By Capt. JACQUES COUSTEAU

PHOTOS BY W. STEVENSON BACON

How do you convey to the people of the world the magnificent vistas that lie beneath the ocean? I have a life-long love of it, and of adventure; and a few years ago we were given the opportunity to communicate this love, this source of inspiration, to the public via the medium of television.

By now our programs ["The Undersea World of Jacques Cousteau," ABC-TV], produced by myself and Alan Landsburg, Metromedia Producers, have been seen by millions. Aided by my best team of

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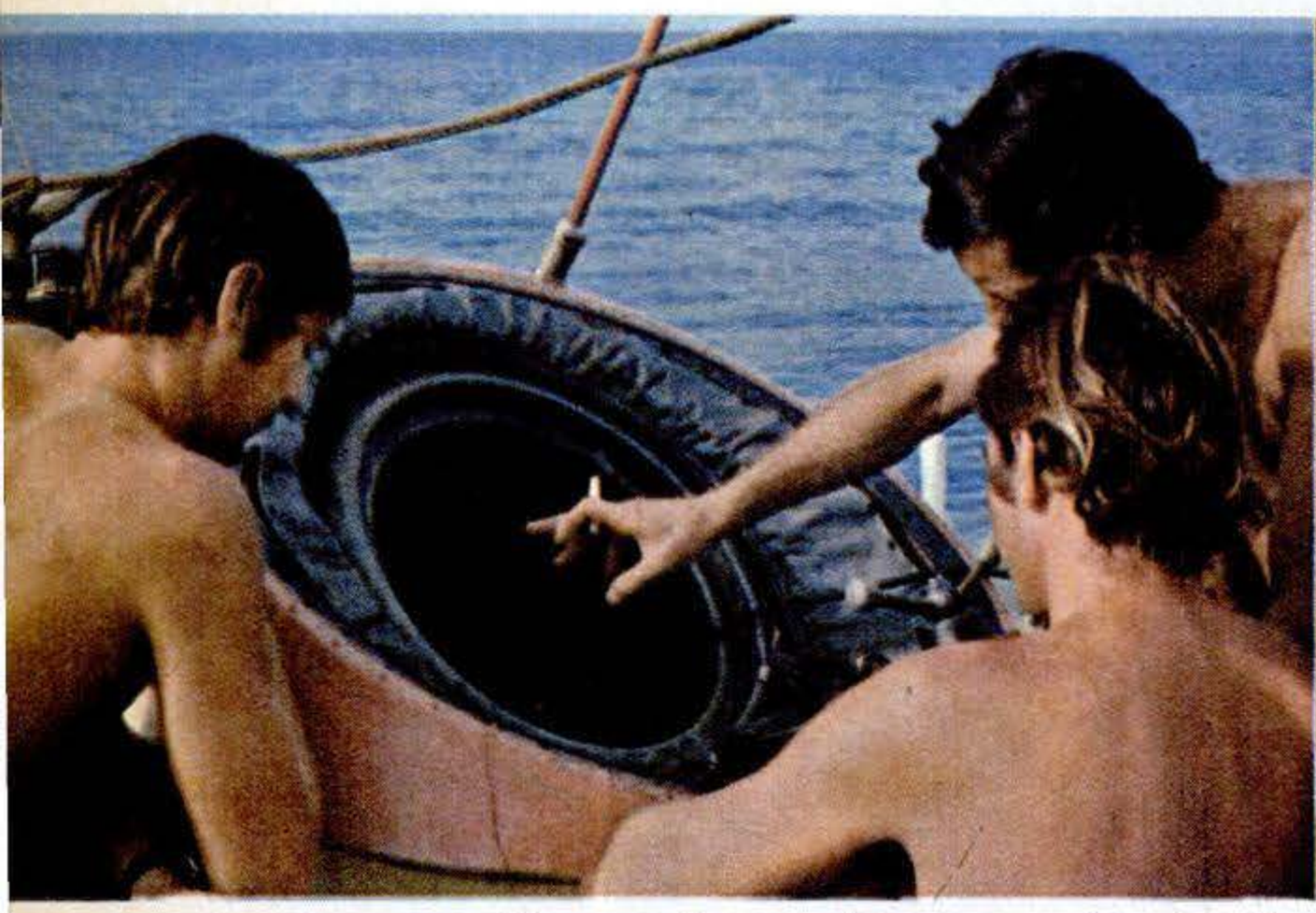
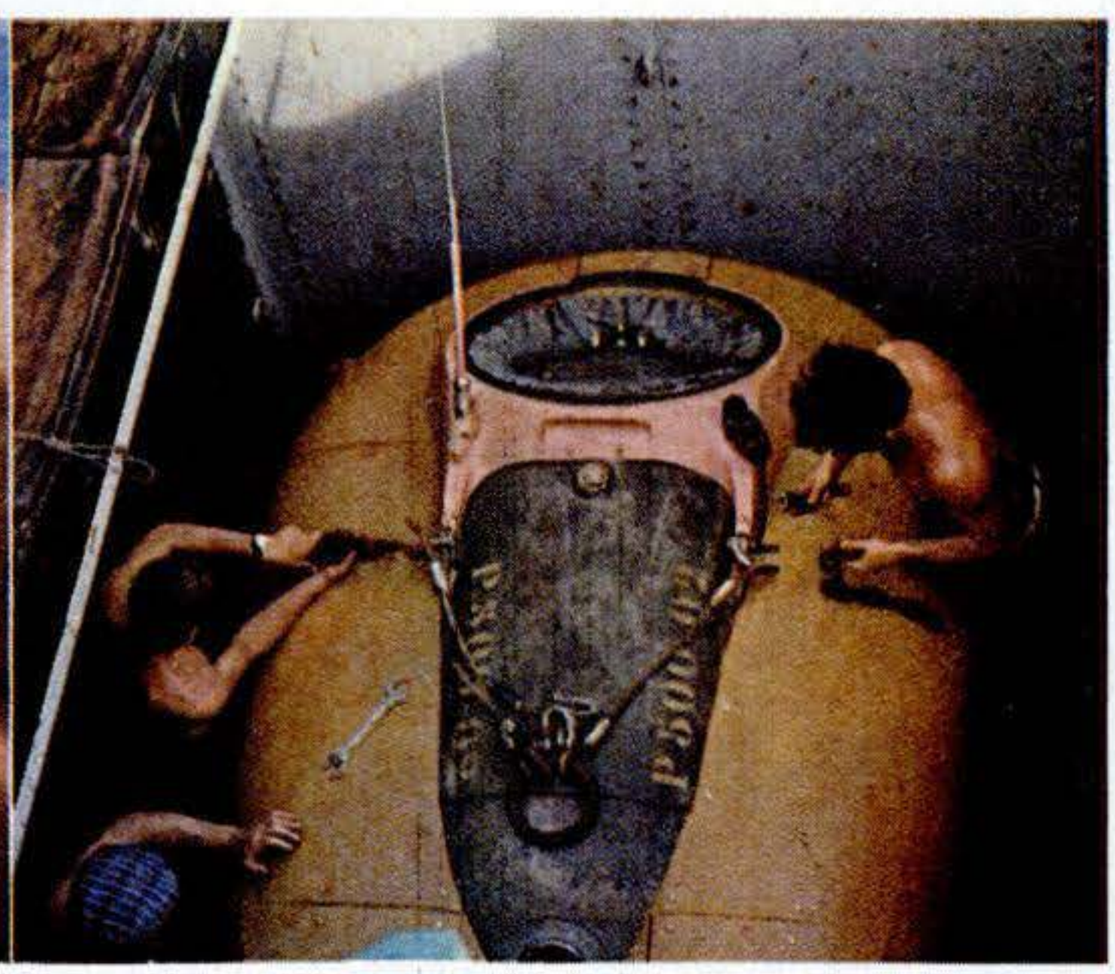
Fiberglass cover is removed from Sea Flea to ready it for overhaul. With pressure hull of steel nearly a half-inch thick, sub usually operates down to 1,500 feet, but it can go well beyond 3,000 feet.



Crewmen discuss minor problem encountered with sub inverter. Inflatable collar around hatch springs up to form tower for emergency exit in heavy seas.



Winch cable is attached to second Sea Flea stored in "well" beneath the Calypso's afterdeck. The two subs are used together for filming episodes.

divers and other underwater experts we have tried to show the viewer the strange and wonderful forms of life that exist in the ocean and the enormous natural riches it contains. We have tried to communicate some of the excitement we feel at being among the first to explore man's last great frontier on earth.

Tools for exploring. Not the least of my reasons for embarking on this great adventure is the fact that fascinating, if expensive, new tools are now available to help us capture some of the wonders of the ocean on film.

Among the main ones are our pair of tiny one-man submarines, which we have dubbed the "Sea Fleas." Before explaining how they work, a few other items: Our color-movie cameras (two are carried by each submarine) were engineered by us

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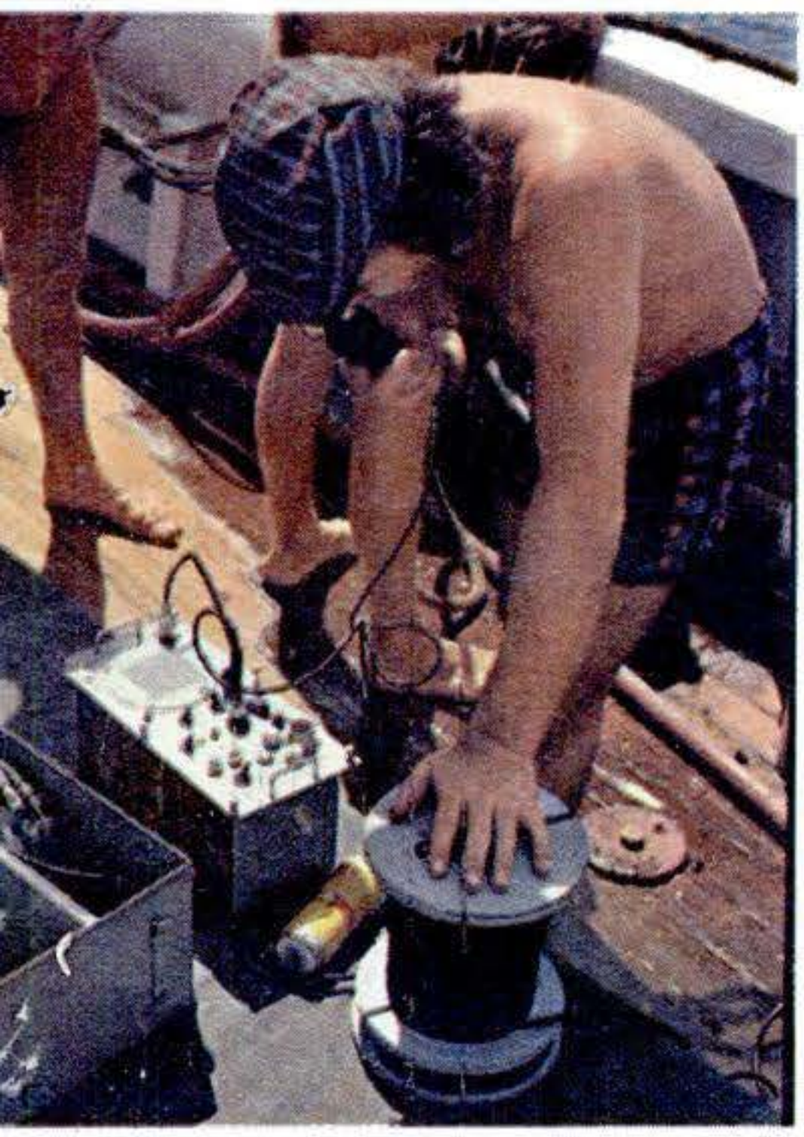
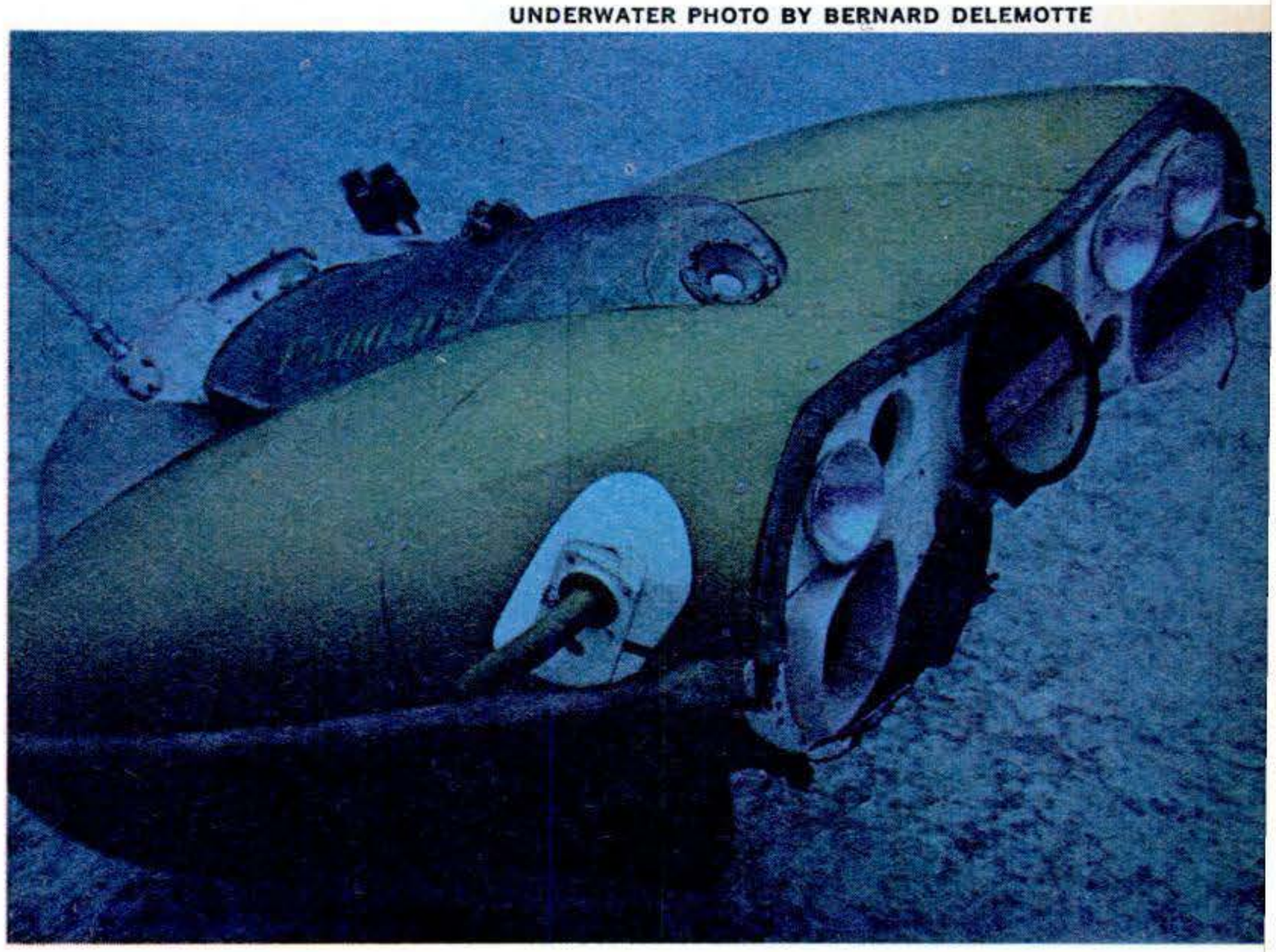
Engineer Jacques Roux overhauls two-hp. electric pump motor (foreground) that propels sub. Water exits via jet nozzles.

Streamlined backpacks of Calypso scuba divers contain batteries for lamp, radio, and sonar as well as the air supply. Radio antenna on top of helmets gives divers other-world look.

UNDERWATER PHOTO BY BERNARD DELEMOTTE



Roux communicates with submerged sub by sonar telephone. Device operates at 40 kHz, has mile range depending on conditions.



Tiny Sea Flea is very maneuverable underwater (note side jet nozzle). Detachable weights adjust depth; a mercury system, the trim.

and contain special optics. They are usually operated as handheld units by our scuba divers.

The scuba gear was also designed by us. Each outfit contains a helmet radio transmitter for the diver to communicate with our ship, the Calypso, when he surfaces. Other features include a sonar transmitter for underwater communication between individual divers and between divers and the ship. The outfits have built-in lights, compasses, an emergency signal that can be heard a mile away, and emergency signal rockets. Last but not least is a shark billy to push the sharks away when they are too many.

The Calypso herself is worthy of mention. A former minesweeper which we first outfitted for oceanography in 1950, she

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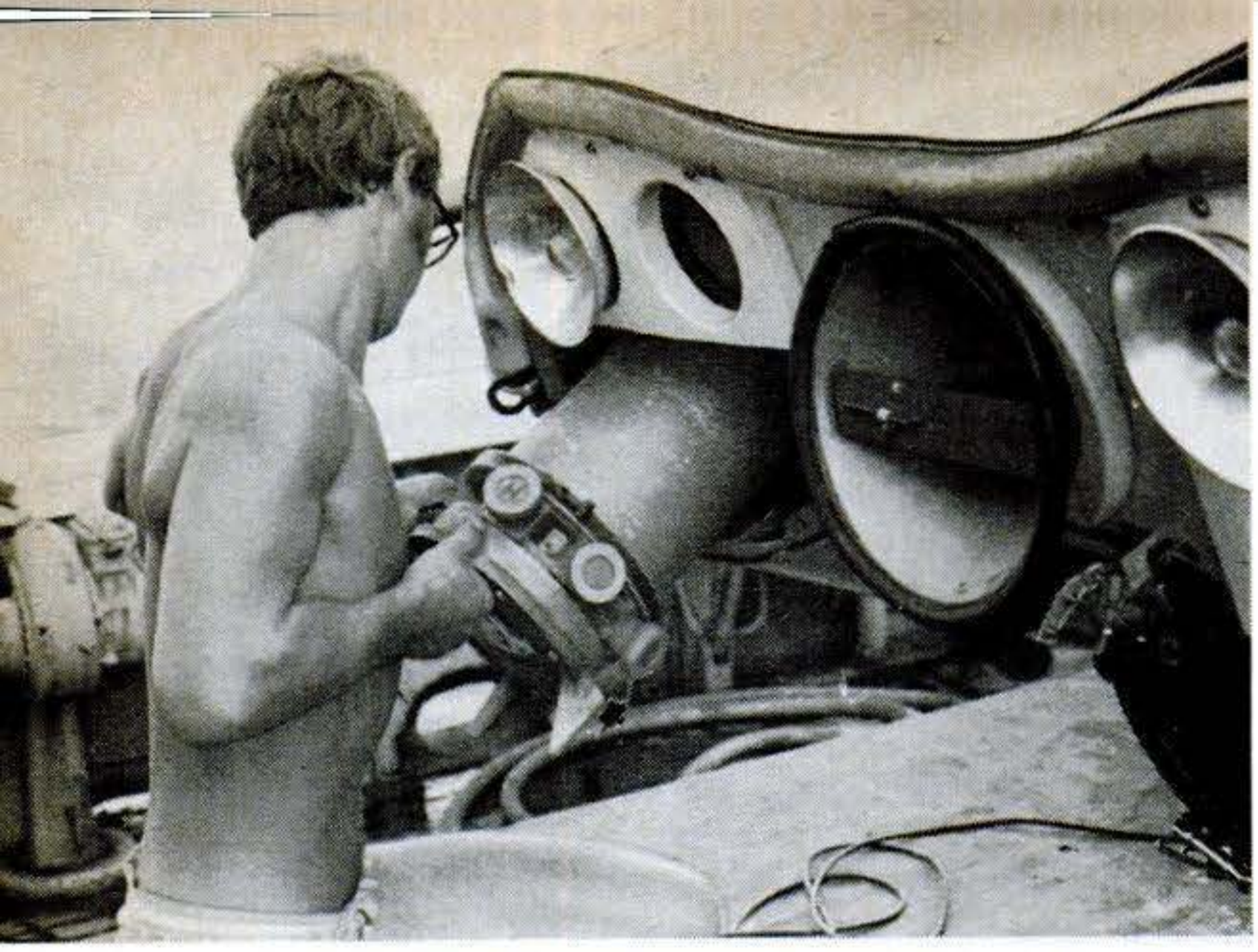
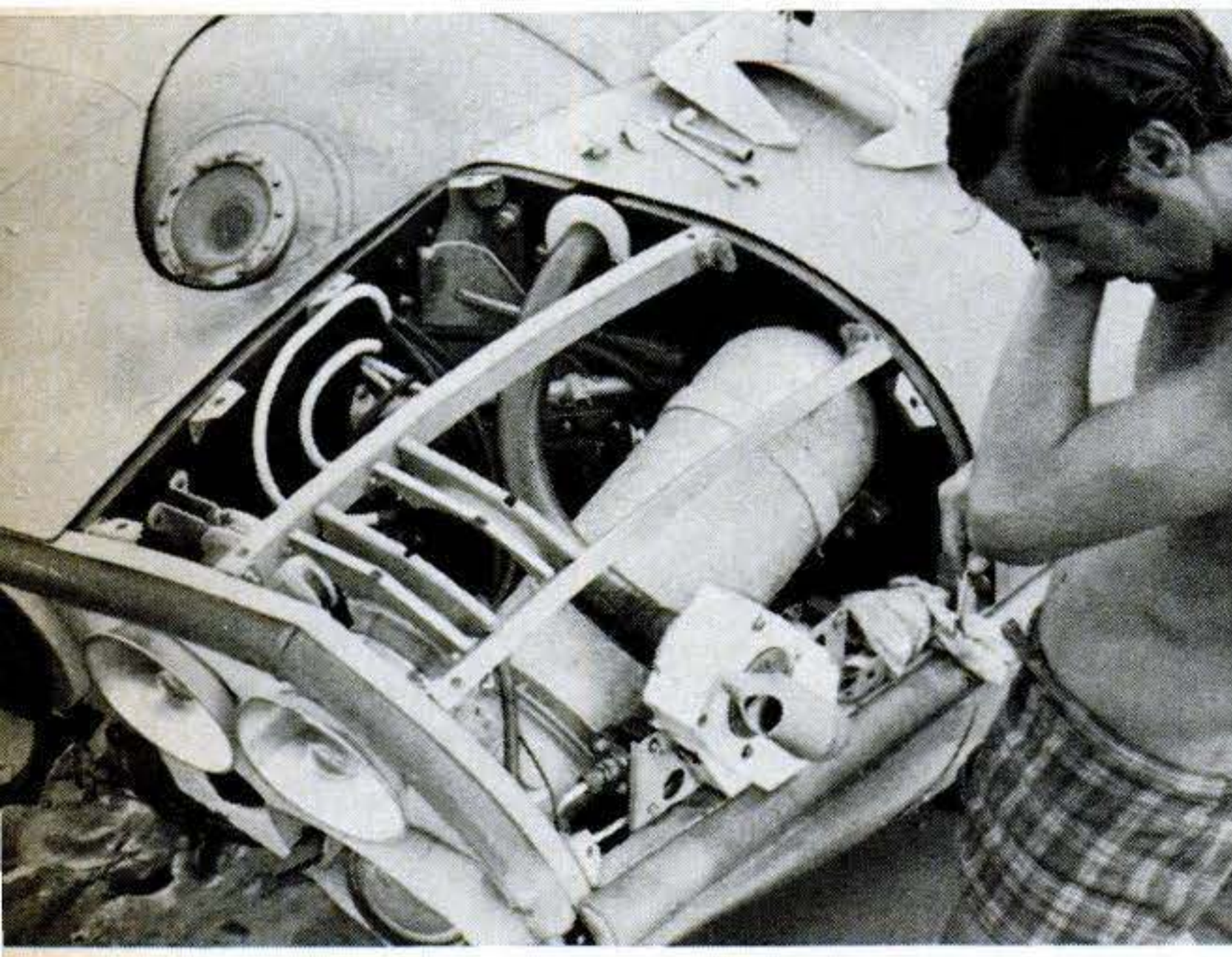


One of two movie cameras carried by the sub is installed (both 16mm and 35mm are used). Lens openings and camera motors are controlled by pilot.

Preparing for training dive is Michel Deloire assisted by Raymond Coll. Pilots climb into sub on deck; hatch is sealed and vessel is swung overboard.



Camera capsule is visible with fiberglass cover removed. At front are two of the three 750-watt movie lights. At top of sub is one of four viewing ports.

includes such things as a built-in underwater observation station in her bow, closed-circuit TV monitors, laboratories, and living facilities.

The Sea Fleas. The tiny subs, which take anywhere from 10 to 100 percent of the film for our "specials," are a story in themselves. The real breakthrough here is that they are small and easy to handle. They do not need a large, specialized vessel as a tender. They are a unique new tool for oceanography, for they can be deployed out into the ocean like a school of fish—with all the maneuverability and observational capabilities of small underwater creatures.

The basic features of the Sea Fleas were proved in my 1959 Diving Saucer—which, by the way, has been the ancestor of all modern underwater vehicles. The most important of these features are jet propulsion with two side nozzles; extreme maneuverability through 360-degree rotation of these nozzles together or separately; static buoyancy finely adjustable both ways; safety devices such as an inflatable hatch "tower" for exit in heavy seas; mercury ballast to instantly tilt the sub; extreme streamlining to avoid entanglements; and hydraulic controls.

The Sea Fleas proved themselves magnificently during their more than 100 hours of operation in some 50 dives. Practice makes them easy to handle, though at first I found them a bit like women—seductive and unpredictable. This last was, of course, due to their extreme miniaturization.

Inside the subs. Crawling into the sub's rear hatch, the pilot lies prone in the three-by-6½-foot hull, looking out through the lower front porthole. His instruments include a barometer, a CO_2 meter, clock, gyrocompass, two F (fathom) meters, tape recorder, radio for surface communication, pinger (for pinpointing the sub's location), echo sounder, and underwater telephone.

A single control stick and rationalized controls make it easy for the operator to be both pilot and observer. The control stick takes the sub up, down, forward, back, or sideways. When it is moved from port to starboard, it controls the rudder. Back-and-forth movement activates the mercury trim system. The stick also holds switches for the propulsion pump motor,

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camera, and lights. As you can see, our pilot easily becomes a camera man, working in perfect harmony with the sub to record anything of interest that he sees in the ocean depths.

Cameras, lights, action. Energy for the Sea Fleas comes from 62 two-volt lead-acid cells in four battery boxes beneath the outside fiberglass covers. These are open to sea pressure and are simply topped with oil. In addition to powering the two-hp. propulsion motor and the instruments, the batteries provide light for sailing and for photography.

Looking like giant eyes, three 750-watt iodine lamps mounted in the front of the sub give enough light for color pictures. Any two lights are used at a time, illuminating the ocean depths for either of the

[Continued on page 184]

On board the Calypso—a life of endless adventure

Captain Jacques-Yves Cousteau's love of adventure carries him to the far places of the globe, and it was to distant ports that PS traveled to bring you this story.

Life on board the French ship Calypso, which we sampled during an eight-day voyage between San Juan, Puerto Rico, and the Canal Zone, is never routine. There is an immensely knowledgeable crew—divers, photographers, engineers, oceanographers—men for whom voyaging is a way of life.

Stopping at small, almost unknown islands on our way across the Caribbean to test-dive the small one-man submersibles illustrated here, we found each day filled with incidents that might have been taken from a novel—except they really happened.

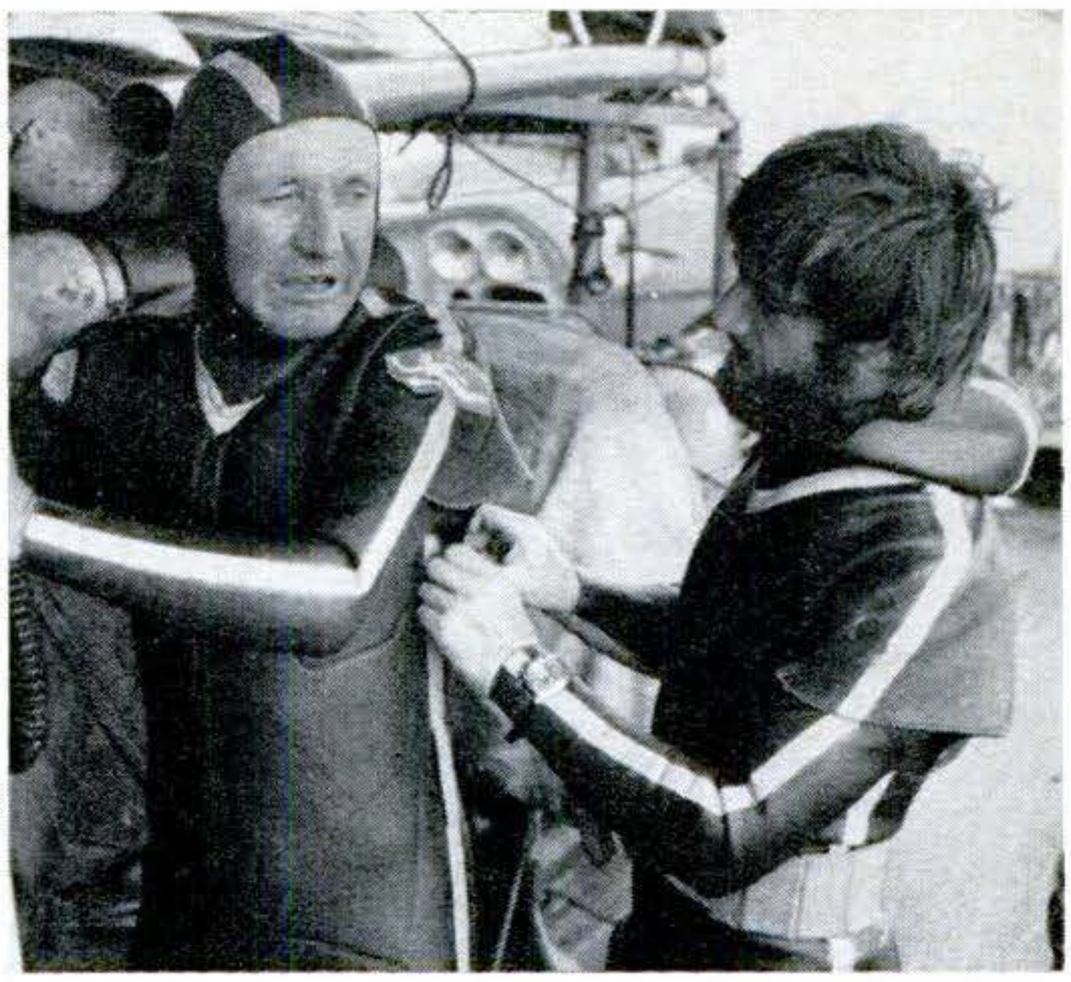
Object of the curiosity of the islanders, the Calypso was boarded a number of times by local residents, on one occasion with loaded pistols. She was suspected of carrying contraband or perhaps of being engaged in searching for buccaneer Henry Morgan's gold—thought to be in the area.

On another occasion it was our pleasure to make the acquaintance of a voodoo practitioner (or "witch doctor," as he called himself), one of many believers in the black arts who live in this part of the world.

The principal surprises came from the sea, however. In the clear warm waters of the Caribbean we saw sharks, stingrays, barracuda, and colorful smaller fish. Phosphorescent plankton illuminated the sea, and schools of flying fish were a diversion.

It is these surprises Capt. Cousteau regularly presents to TV viewers. If anything, the amazing sights he has brilliantly captured for the home screen are an understatement of the real thing.—*W. Stevenson Bacon*

Much underwater film footage is taken with hand-held cameras with self-contained batteries and light. They weigh 75 pounds—very little in the water.



World authority on scuba diving, Frederic Dumas (left) is assisted with wet suit by J. Clair Riant. Dumas is one of experts who assist Cousteau.

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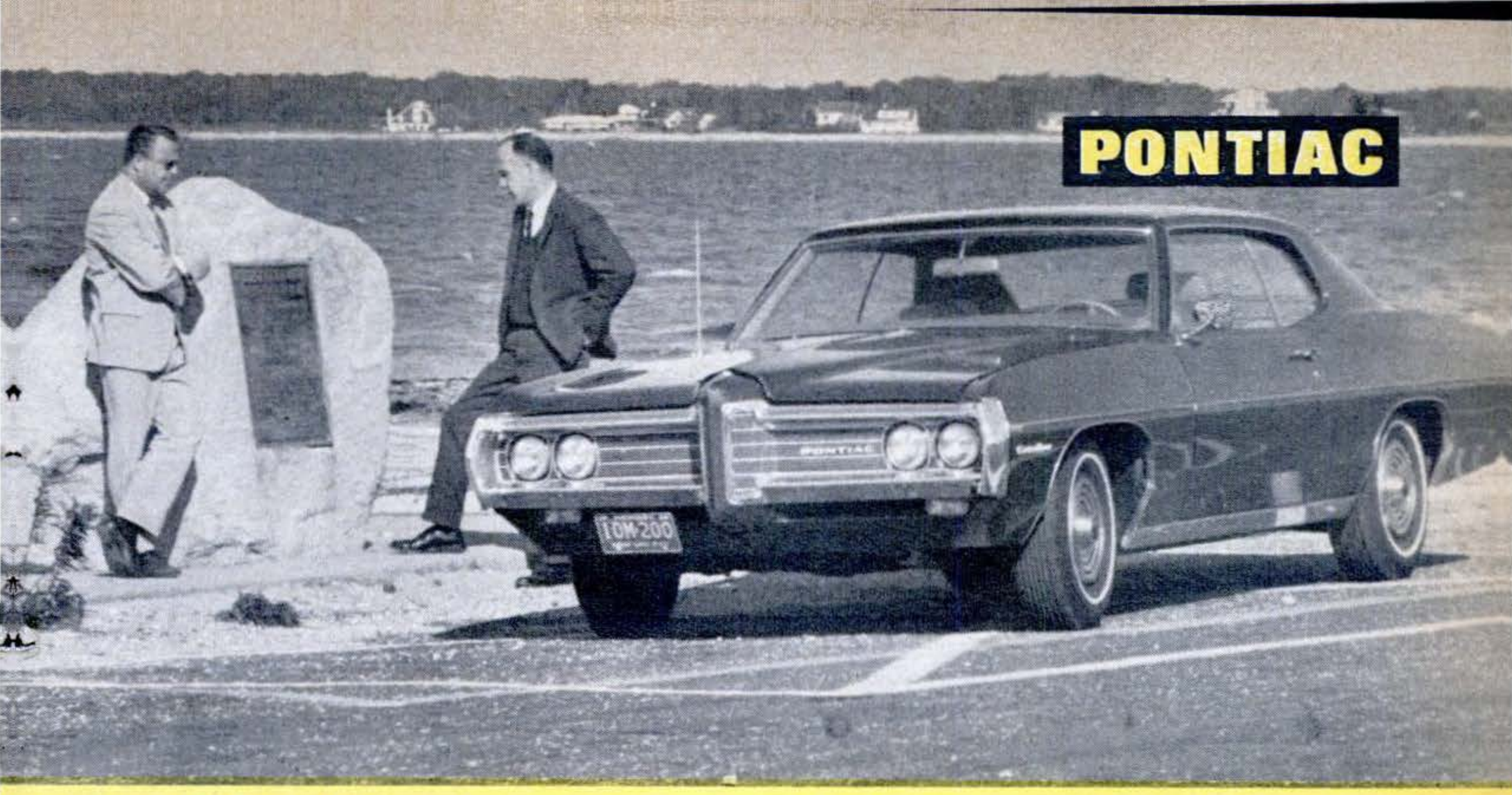
Chevrolet Impala is the shortest of the full-size cars tested, but it has ample interior space.

NORBYE·DUNNE PSERIES REPORT

THE FULL-SIZE FAMILY CARS: Biggest Bargain for Your Buck?

All these cars offer great value. Here our test team tells you how good they are, and in what ways they differ

Plymouth Fury III is livelier than either Ford and Chevy, yet it proved to be less fuel hungry.



Pontiac Catalina is the longest, roomiest, most powerful, and most expensive of the four cars.

By **JAN P. NORBYE** / *PS Automotive Editor* and **JIM DUNNE** / *PS Detroit Editor*
PHOTOS BY DAVE HOUSER

There's a lot to be said for Detroit's full-size cars. Equipped with big V-8s, power steering, power disk brakes, and heavy-duty suspension, they're roomy, comfortable, speedy, safe, and well-appointed. Yet within their overall dimensions, it would not have been difficult to design for even more useful space. Or a smaller package could have been designed around the same interiors. [See the Iso S-4, page 120.]

The cars are heavy, which makes for a quiet ride and high directional stability. But weight is also the enemy of acceleration. It increases fuel consumption and tire wear, throws an extra load on brakes, and can cause handling problems.

These pros and cons apply to all four cars and we evaluate them in this light.

We ordered two-door hardtops. Plymouth was unable to deliver one with the drive train and chassis options we specified, and supplied, instead, a four-door hardtop that met our mechanical specifications for the tests.

After hundreds of miles in each car, we can argue the case for heavy-duty suspension more strongly than ever. Many unsuspecting passengers praised the ride comfort, even in town traffic. The poorer

Continued

Ford Galaxie is happiest on the highway, with its excellent high-speed handling and stability.

Ford's small controls are out of reach when you're in a normal driving position. With outstretched arm, Norbye's hand is still five inches from key.

Galaxie hardtop's doors are enormous, giving easy access to rear seat. Dashboard is swept forward, away from front-seat passenger, for more safety.

the road conditions, the greater the advantages of the HD springs and shocks. From this experience, we can see no justification for standard suspension at all. And HD suspension is a bargain at prices ranging from $6 to $24 on these models.

We mentioned safety. The most important new features have to do with impact protection, and we did not crash-test our cars to check them. In case you have forgotten, Chevrolet and Pontiac have guard rails built into the doors for side-impact protection, and the front section of the Ford frame is designed to absorb a head-on impact at a controlled crumple rate. All have "headrests" and more belts and buckles than you can find your way out of.

This mass of belts and buckles is one of the main irritants on '69 cars. Neat storage is difficult, and we fear too many people will choose to ride without upper-torso restraints rather than tangle with the mess that results. The GM cars use locks of different size to help you differentiate between lap belt and harness, but there are still too many loose ends every time you try to buckle up.

These cars are built for the same overall purposes and have the same general character. All are powerful, quiet, well finished. Noise levels are so low that slight noise (from a radio antenna, say, flagging in the wind) becomes more noticeable than in lower-grade cars. Though heavy and very stable in crosswinds, the cars still showed quick response and balanced handling in our tests. There are also important differences between cars. Let's examine them in full detail, one by one.

CHEVROLET

When you're at the wheel of the Impala, it feels smaller and handier than its size and weight lead you to expect. Excellent quick steering and a clear view from the driver's seat help you feel at home right away. Small neat-looking controls are well grouped. The instrument panel has a long row of warning lights, and in addition to color-coding, the words—*brake, hi beam, oil, temp*—are spelled out in white, but are visible only when the light goes on. When everything is normal, there is nothing to distract you.

In typical GM fashion, the Impala's interior is rich looking. The quiet ride adds to the feeling of luxury. Outside, the vinyl rub rail along the widest part of the body is standard.

On the minus side, we found the wipers unduly noisy in operation. The seat-back locks are inconvenient, and getting in and out of the back seat was not easy. We were disappointed in the braking performance (rear-wheel locking problems), and we needed two small repairs: A loose union in the oil-pressure sender pipe caused loss of oil, and the grease cup on the left-front wheel hub came off in a high-speed turn.

FORD

The Galaxie's front seat is extra spacious and designed for safety. The doors are enormous and give easy entry to the back seat. The seat-back locks, high on the side, are the best in the business.

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Pontiac hood has poor fit—or so it seems. Actually, the rubber-bumper-and-grille assembly can easily be adjusted up and down to fit flush with hood line.

Pontiac steering wheel is vinyl-covered and gives a good grip. Wheel size proved ideal, and the three horn buttons in the spokes are convenient to use.

While the aircraft-style instrument panel looks advanced, the layout of small controls caused serious problems.

Most controls are out of reach from a normal driving position. You have to bend forward for every little thing. The light switch is hidden under the dash—not far from the brake release which is easily confused with an air-vent handle. The radio is in the upper left corner of the panel, so only the driver can reach it. We think this is a mistake—playing with the radio can be fun for a passenger but just an extra chore for the driver. The glove box is so small as to be almost useless—truly for gloves or glasses.

The brakes faded in the final stop, and the steering was so slow that low-speed maneuvers became a chore. The old Y-block 390-cubic-inch V-8 is a reliable workhorse, but a very heavy gas eater.

PLYMOUTH

The new Fury with the fuselage-type unit body has nice solid-sounding doors when you slam them. The floodlighted instrument panel looks modern, and small controls (except for the left-hand key) are handy. The Chrysler-type inside door handles are unquestionably the best, but the interior finish looks cheaper than that in the other cars. The right door-lock button came off, forcing us to use the key every time. The turn-signal lever has no step for lane-changing. The car has front-door vent windows and no upper-level ventilation, unlike all others in this group.

The worst objection to the Fury is the

Continued

Grease cup repeatedly fell off the left-front wheel hub on the Impala—a poor press fit that the factory's quality-control men somehow had failed to catch.

Prior to brake-testing the Catalina, Norbye attaches the m.p.h. cable to the fifth wheel while Dunne prepares to hook it up to the electric speedometer.

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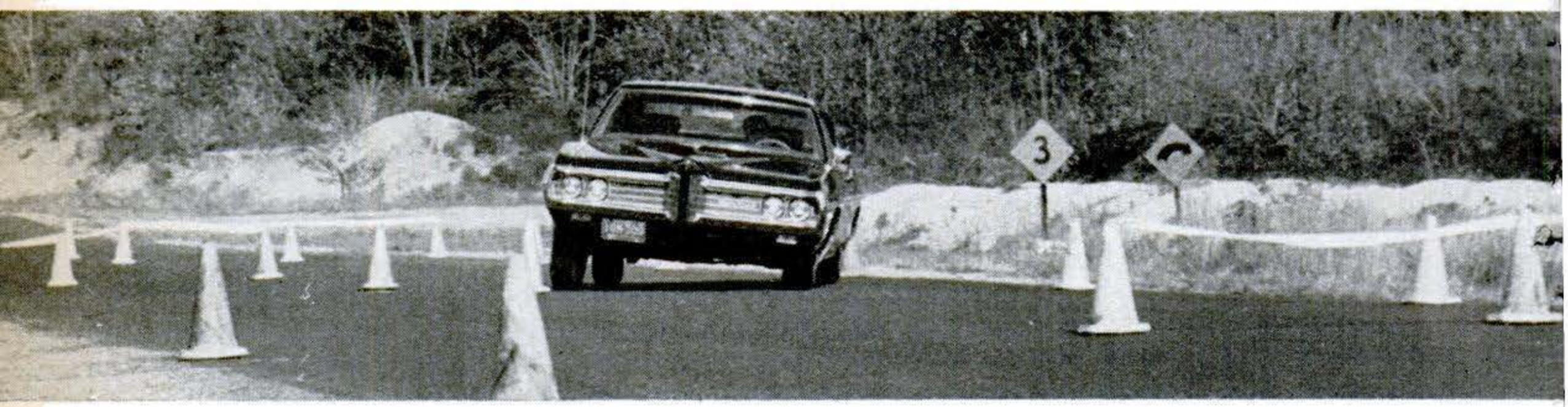
Lane change: Plymouth has little body roll but lots of drift—it just missed cone ahead of wheel.



Lane change: Pontiac rolls more but handles more precisely; VRS makes for quick response.

noise and vibration in the unit body. Regardless of road surface, the interior of the Plymouth is never as quiet as the other cars (which have separate frames and bodies). The TorqueFlite operates on higher pressure than other automatic transmissions, and gives very positive, sporty shifts—but is not smooth. The transmission also made a loud noise whenever we shifted from Neutral to Drive or Reverse (at idle).

PONTIAC

The Catalina impressed us with its outstanding performance and total reliability. Pontiac has pioneered standardization of very "long" axle ratios and variable-ratio steering. And their fearless approach to engineering has also led to a surprisingly efficient engine—it was best on acceleration, and second only to the Plymouth on fuel economy.

If the instrument panel seems old-fashioned, it's simple and clean-styled, and all controls are within easy reach. The vinyl covering of the steering wheel looks neat and provides a good grip even when your hands are sweaty. Pontiac not only has the vinyl rub rail on the body sides, but a stylized front bumper of special rubber. The Pontiac's drawbacks are the same as those of the Chevy: poor rear seat entry, noisy wipers. But GM's articulated wipers are among the most effective.

CONCLUSIONS

DUNNE: My choice is the Pontiac. It's a solid car that you can trust. The '69 Catalina is quiet, powerful, and has a really expensive look from the outside. One big drawback is the old-fashioned instrument panel—but that steering wheel is a gem!

NORBYE: I'll go for the Chevy. Its fast straight-ratio steering suits me better than the variable-ratio in the Pontiac, and I think its handling response is more predictable. It's obvious that, for '69, Chevrolet has put more money than usual into the Impala, probably in an effort to take the lead away from Ford in the area of comfort, luxury, and quiet. I think Chevy has done it. PS

Lane change: Impala was beautifully obedient right up to its limit in this test. Body roll and steering angles proved moderate throughout this ordeal.

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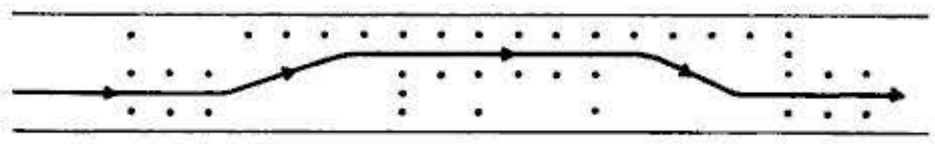
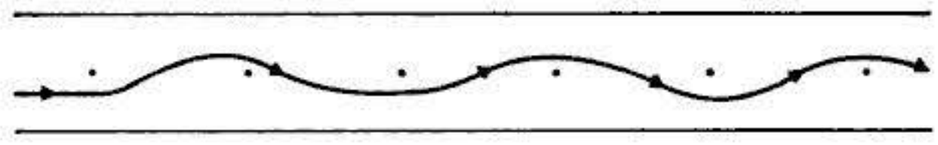
How PS tests cars—and what our tests are intended to show

BRAKES This test shows a car's ability to stop in a straight line after repeated stops (as in stop-and-go highway traffic). Ten warmup stops from 60 m.p.h. at one-minute intervals with half-g (16 feet per second per second) are followed by a final stop for minimum braking distance without wheel locking in a 12-foot-wide lane. Pedal pressure is recorded on all stops. Excessive pressure indicates fade.

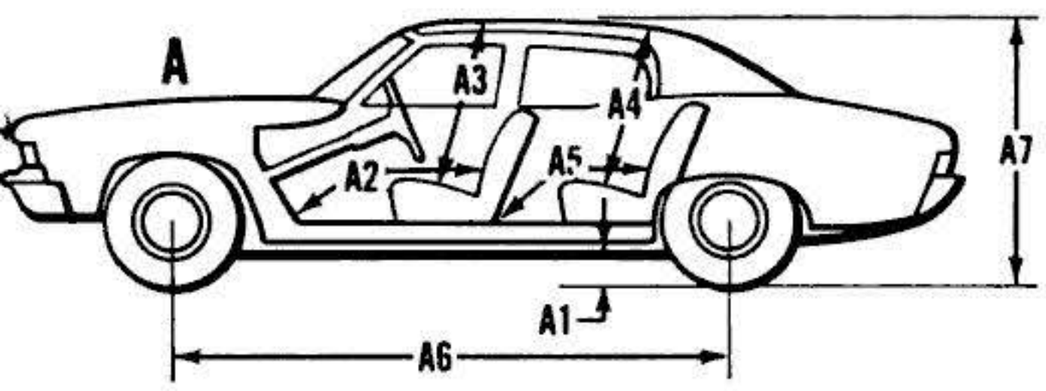
ACCELERATION The 0-60-m.p.h. test shows a car's ability to reach cruising speed from standstill; 0-80 test shows its high-speed power reserve; 25-70 m.p.h. test simulates a highway merging situation or passing on a two-lane road. In all tests, the car is in Drive.

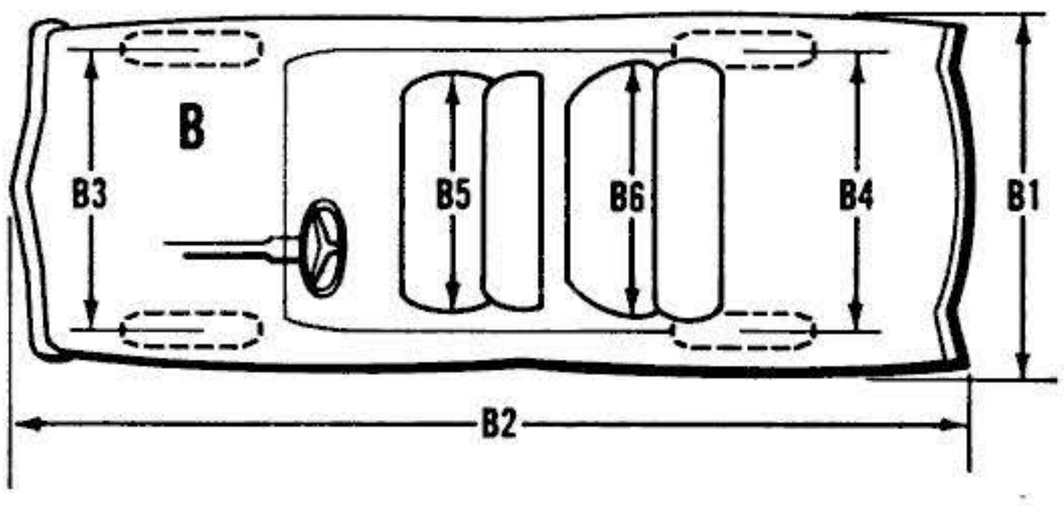


LANE CHANGE Two lane changes in quick succession show a car's ability to make an emergency maneuver at high speed. The lanes are blocked 120 feet apart, and each lane change must be completed within 60 feet. Each car is put through the test at increasing speeds until its maximum is established.



MANEUVERING Snaking a car as fast as possible through pylons spaced 48 feet apart shows its ability to negotiate narrow, winding roads or heavy city traffic where sharp turns are needed to avoid a stopping bus, double-parked truck, or car pulling out from the curb.





DIMENSIONS (inches)	CHEVROLET Imp Ia	FORD Galaxie	PLYMOUTH Fury III	PONTIAC Catalina
A1 Ground clearance	5.7			5.3
A2 Front leg room (max.)	41.4	41.8	41.8	42.4
A3 Front head room	37.7	37.8	38.0	38.6
A4 Rear head room	37.5	36.9	37.2	37.8
A5 Rear leg room (min.)	35.1	35.7	38.6	34.1
A6 Wheelbase	119.0	121.0	120.0	122.0
A7 Height	54.0	53.5	55.8	54.8
B1 Width	79.8	79.4	79.6	79.0
B2 Length	215.9	214.0	214.5	217.5
B3 Front track	62.5	63.0	62.1	64.0
B4 Rear track	62.4	64.0	60.7	64.0
B5 Front hip room	63.6	62.3	63.3	63.7
B6 Rear hip room	55.5	61.1	63.4	55.5
SPECIFICATIONS				
Engine type	OHV V-8	OHV V-8	OHV V-8	OHV V-8
Bore x stroke	4.094 x 3.76 in.	4.05 x 3.78 in.	4.25 x 3.38 in.	4.12 x 3.75 in.
Displacement	396 cu. in	390 cu. in	383 cu. in.	400 cu. in.
Compression ratio	9:1	9.5:1	9.2:1	10.5:1
Carburetion	one 2-barrel	one 2-barrel	one 2-barrel	one 2-barrel
Power @ r.p.m.	265 @ 4,800	265 @ 4,400	290 @ 4,400	290 @ 4,600
Torque (lb.-ft. @ r.p.m.)	400 @ 2,800	390 @ 2,600	390 @ 2,800	428 @ 2,500
Transmission	Turbo HydraMatic	Cruise-O-Matic	TorqueFlite	Turbo H'Matic
Axle ratio	2.56:1	2.75:1	2.76:1	2.29:1
Tires	Goodrich	Goodyear	Goodyear	Uniroyal
Tire size	8.25-15	8.55-15	8.25-15	8.55-15
Turning diameter	43.6 ft.	42.3 ft.	42.8 ft.	43.75 ft.
Turns, lock to lock	2.85	4.1	3.5	2.85
Brakes	disk/drum	disk/drum	disk/drum	disk/drum
Fuel tank	24 gal.	24.5 gal.	24 gal.	24 gal.
Curb weight	4,218 lb.	4,206 lb.	4,172 lb.	4,267 lb.
TEST RESULTS				
Acceleration 0-60 m.p.h.	11.3 sec.	11.6 sec.	11.0 sec.	10.6 sec.
Acceleration 0-80 m.p.h.	19.4 sec.	19.6 sec.	19.8 sec.	18.2 sec.
Acceleration 25-70 m.p.h.	12.4 sec.	12.8 sec.	11.5 sec.	11.3 sec.
Braking distance 60-0 m.p.h.	195 ft. 3 in.	198 ft. 10 in.	175 ft.	161 ft. 6 in.
Brake-pedal pressure	40 lb.	200 lb.	40 lb.	115 lbs.
Max. speed—lane change	58 m.p.h.	60 m.p.h.	58 m.p.h.	58 m.p.h.
Max. speed—traffic weave	30 m.p.h.	23 m.p.h.	25 m.p.h.	28 m.p.h.
Average fuel mileage	11.4 m.p.g.	10.2 m.p.g.	12.1 m.p.g.	11.7 m.p.g.
Price (basic)	$2,910	$2,913	$2,962	$3,157
Price (as tested)	$3,687	$3,886	$3,866	$4,114

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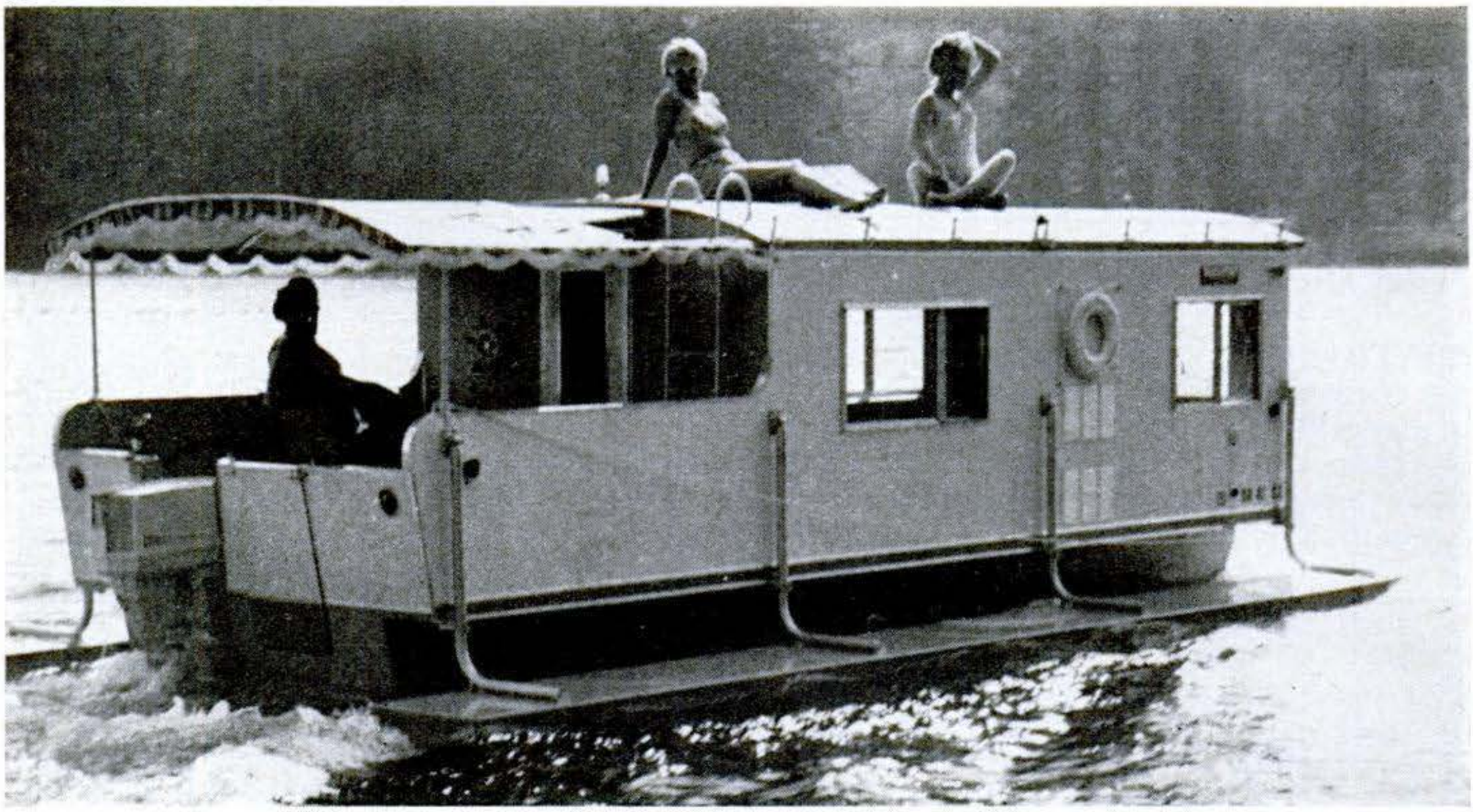

Camper converts into boat

The 21-foot trailer (left) was meant to float. Built by G. E. Husted of Eugene, Ore., it becomes a houseboat when unhitched and launched on a lake (above). Pontoons, stored on the roof when the vehicle is land-borne, flip down on aluminum struts for water travel. A 55-hp. outboard motor propels the trailer-boat at up to 15 miles an hour.

Six 1,500-watt floodlights above Jeep's top aid night firefighting. T-shaped arm is raised hydraulically.

Smoke ejector, with large exhaust fan, sucks 28,000 cubic feet of smoke a minute from burning building.

Midget fire engines go where the big ones can't

The Chicago Fire Dept. has converted forward-cab, four-wheel-drive Jeep trucks into fire trucks that can maneuver into spots too small for big fire engines. They get through streets clogged with larger

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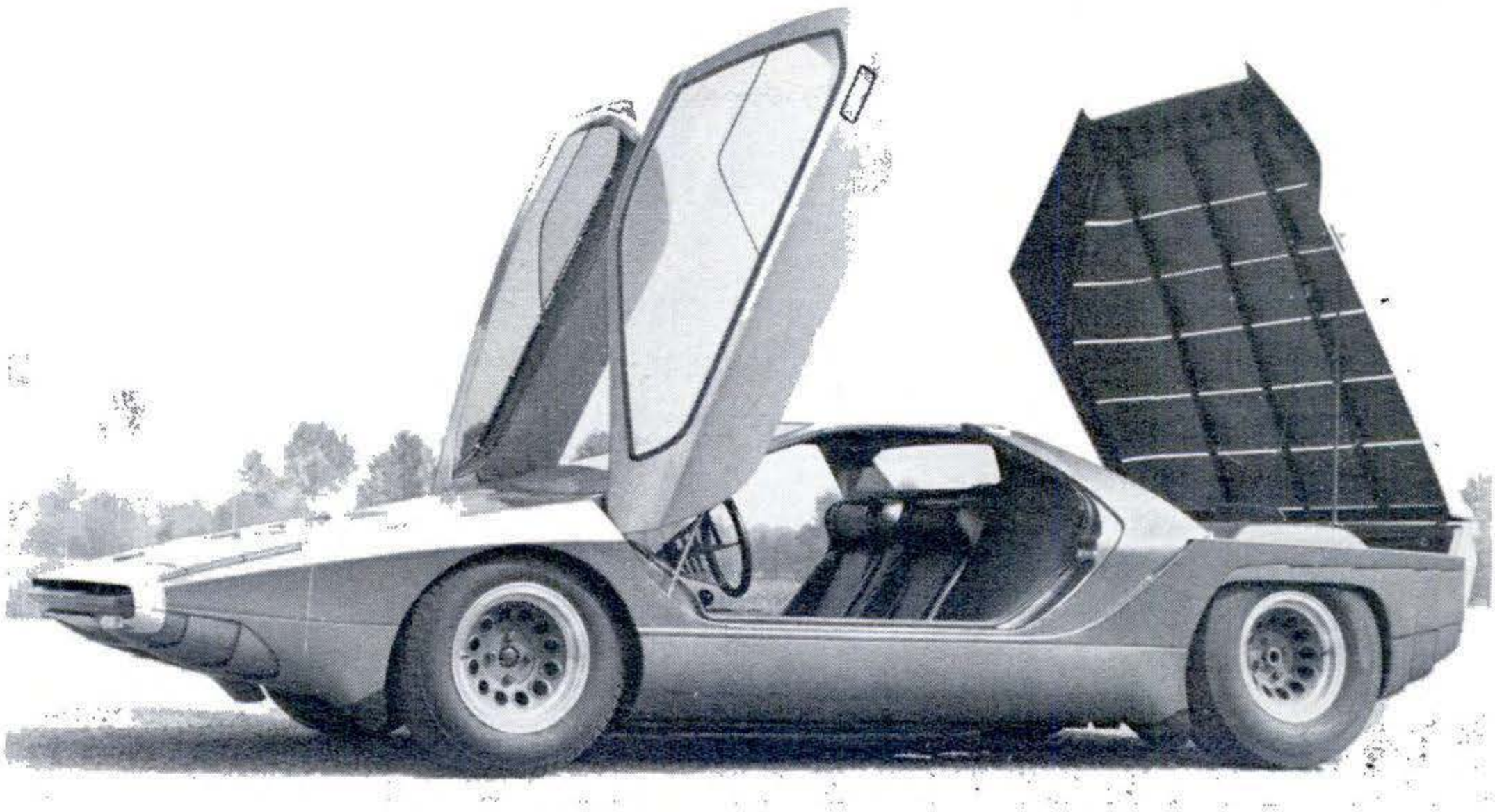
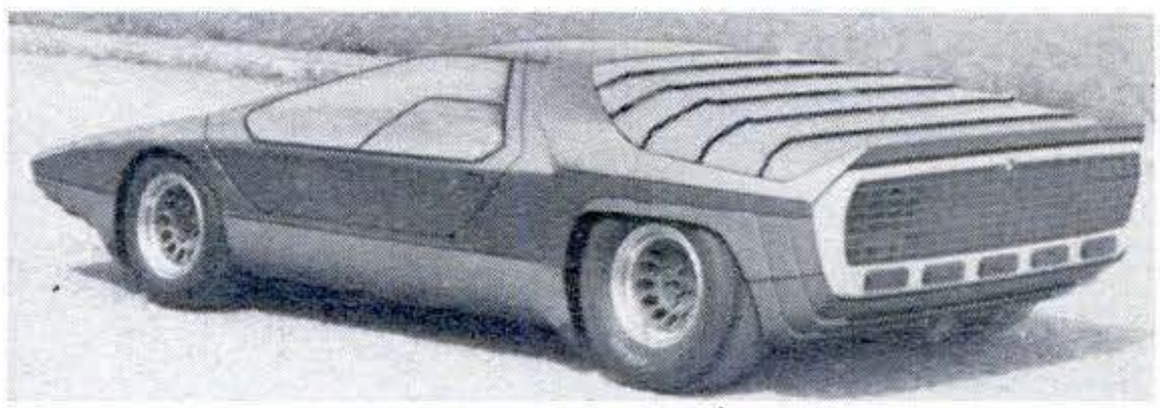


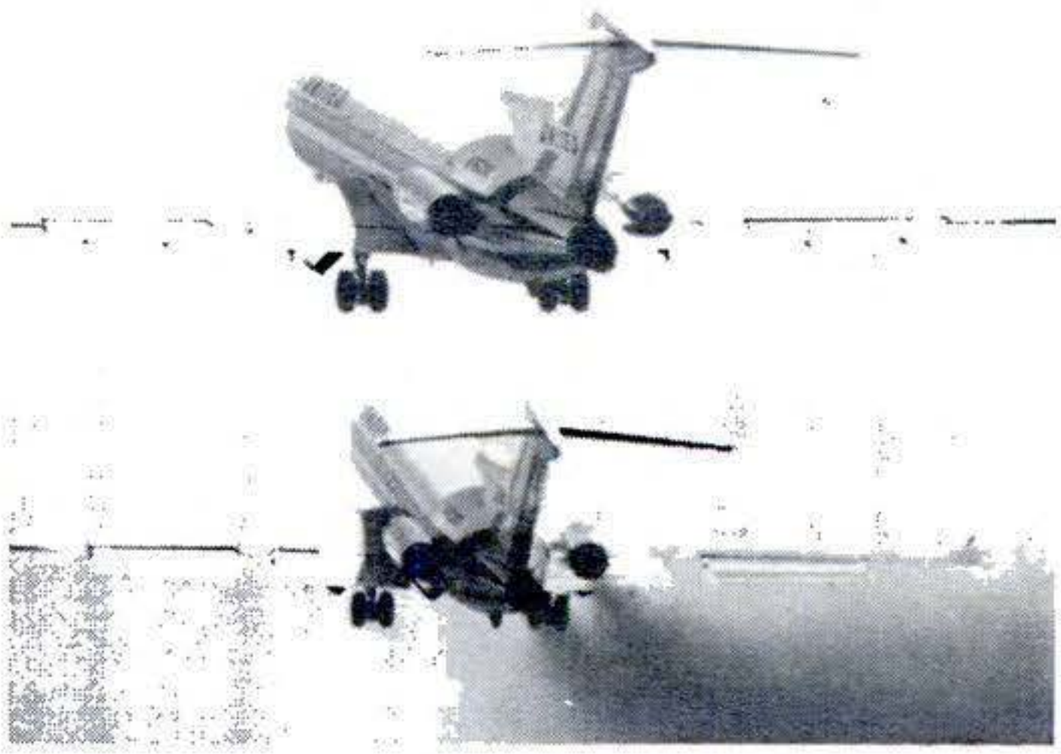
The ultimate fastback?



The wild-looking Bertone Carabo has no rear window. The back of the car is covered by a hinged hood that's louvered for ventilation and rear vision (right). Hydraulically assisted doors open upward, and the steering wheel swings right for easy entry into the 39-inch-high car. Instruments are at the base of the windshield, far forward to reduce eye-focus change between dials and road. Pivoting vanes in the nose cover the headlights.

Jeep pressure wagon, with short wheelbase and light weight, gets near, even into, burning buildings.

trucks, climb steep embankments, roll over fire hoses without damaging them, even enter burning buildings for a quick attack at the heart of a blaze. Cost of the Jeeps: about one-quarter that of a full-size truck.



Modified jet engines burn cleaner

A United Air Lines Boeing 727, top, with new engines, emits no smoke on a full-power takeoff. The power plants have been redesigned with new combustion chambers, and nozzles that spray fuel directly into the chambers. A conventional 727, lower photo, leaves a heavy, air-polluting trail of unburned carbon in a takeoff a few minutes later.

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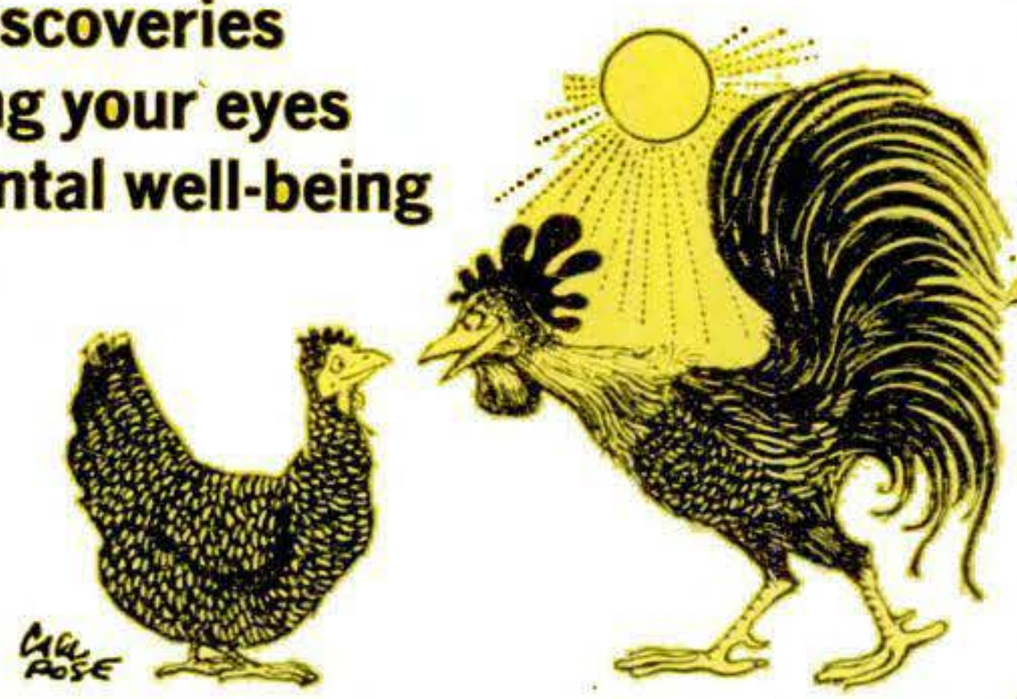
Science probes the mysteries of

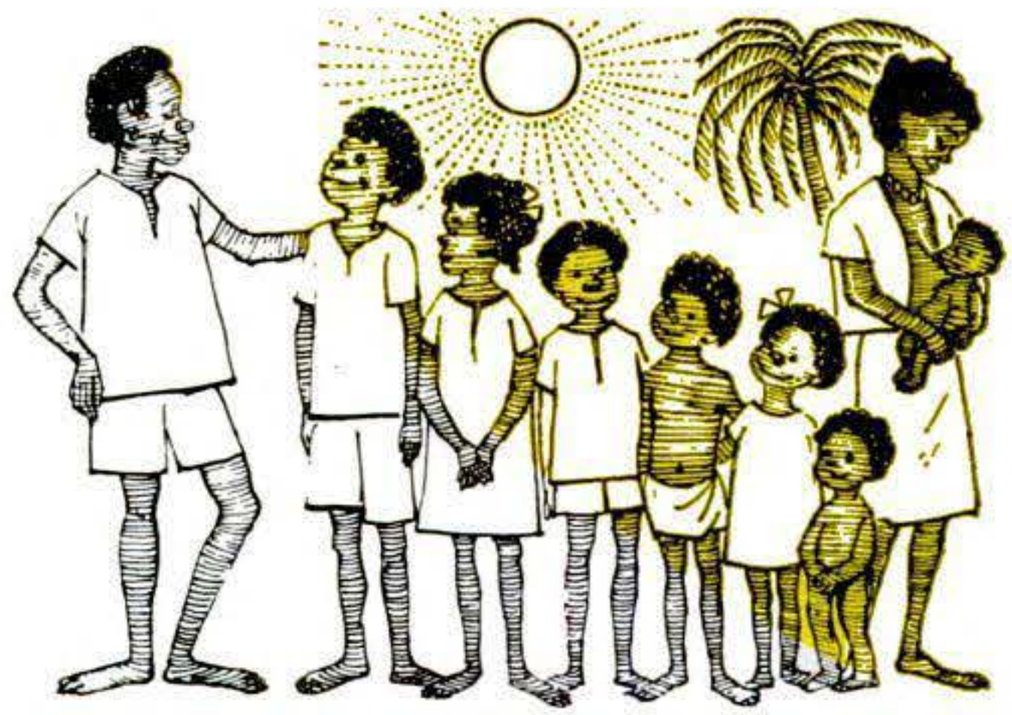
LIGHT AND YOUR

Here are some surprising new discoveries about how the sun's rays entering your eyes may affect your physical and mental well-being

By WILLIAM and ELLEN HARTLEY
DRAWINGS BY CARL ROSE



Chicken farmers increase egg production in winter by using artificial lights in coops.



High reproduction rates in the tropics could result from increased exposure to natural light.

Pink fluorescent tubes were recently installed in the control room of a Florida radio station "to make the surroundings more cheerful." Within two months broadcasters began to goof on the air, tempers rose, and almost everyone got sore at the management.

Two employees quit. Finally, one man said he'd "blow his cork" if those pink lamps weren't removed. So back went white tubes, and, in a week, normal peace and efficiency returned.

A Chicago restaurant, the "Well of the Sea," has used near-black ultraviolet lights in its dining room for almost 20 years. The waiters have far better health records than employees who work under regular indoor lighting in other areas of the restaurant.

Some years ago, Dr. John Ott retired to Florida, hoping southern sunlight would improve his legs, which were severely crippled by arthritis. Sun-soaking failed to help. Then he broke his sunglasses. Sunbathing without them improved his condition in a few days, even enabled him to throw away his cane. Ott found that the sunglasses had filtered out almost all ultraviolet rays from the light reaching his eyes. (He has since developed a full-spectrum lens that admits ultraviolet.)

Such discoveries have convinced investigators that a lack of natural light may be shortening the life of civilized man, impairing his health, reducing reproduction, and even inviting cancer.

Living behind glass. Lack of exposure to natural light is the price man pays for spending up to 90 percent of his life in buildings and vehicles. The glass windows block off the greater part of the ultraviolet end of the light spectrum. Most artificial lights do not replace lost radiations.

Two years ago, Russian scientists N. M. Dantsig, D. N. Lazarev, and M. K. Sokolov stated: "If the human skin is not exposed to solar radiation (direct or scattered) for long periods of time, disturbances will occur in the physiological equilibrium of the human system. The result will be functional disorders of the nervous system and a vitamin D defi-

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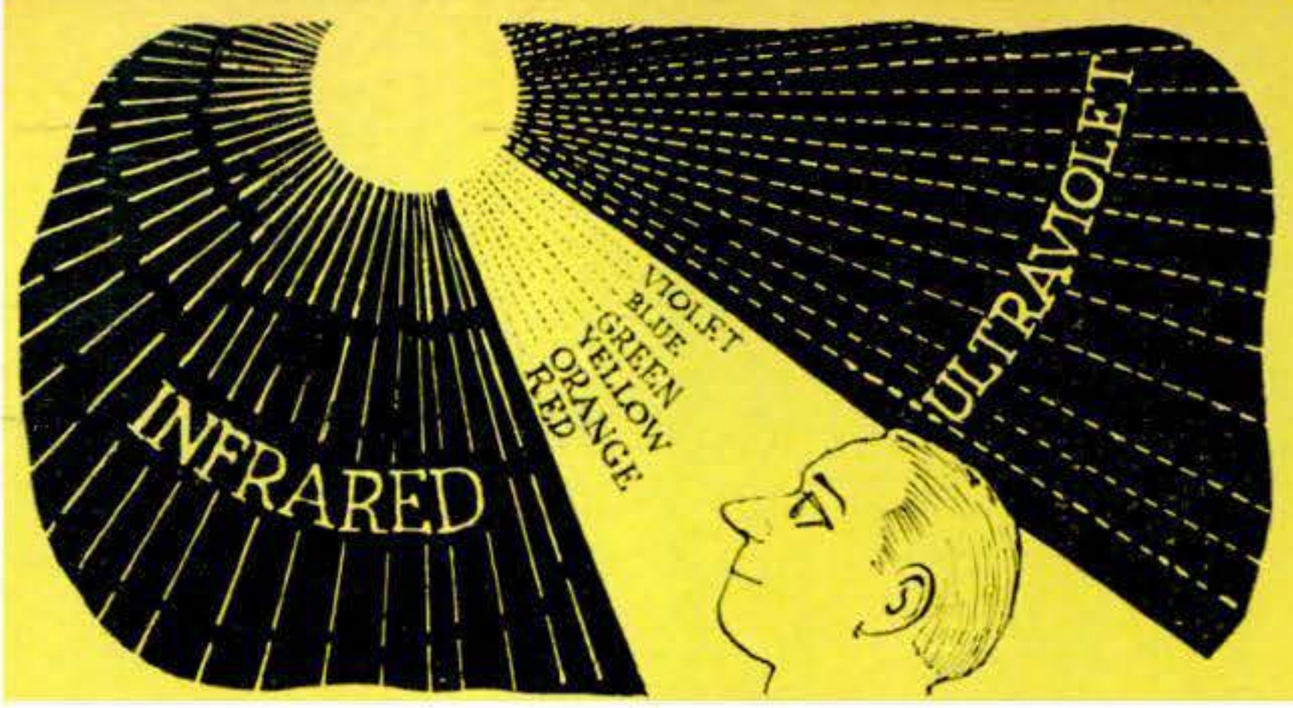
HEALTH

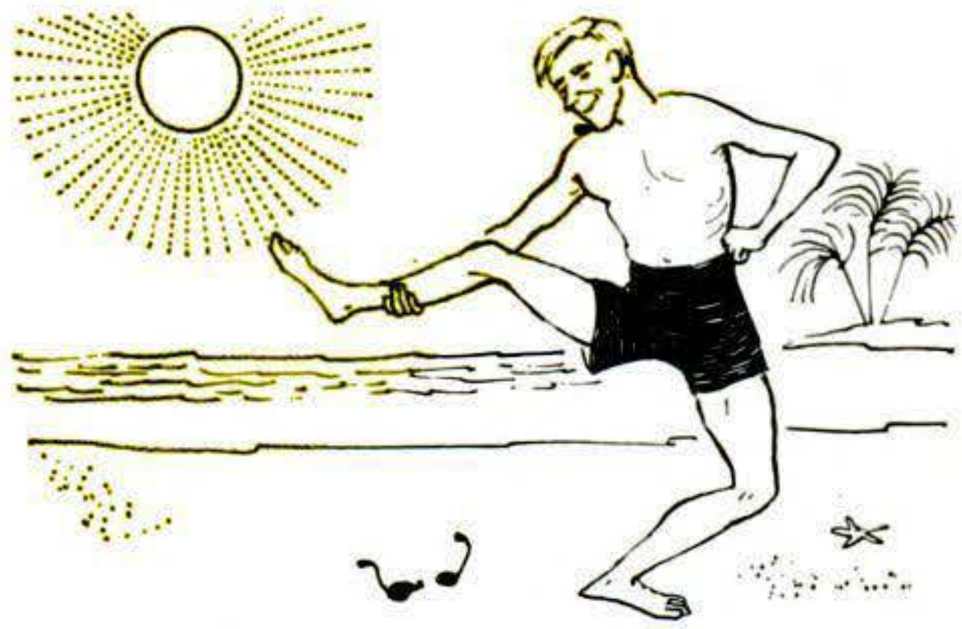


The light you "see" is from the middle of the total light spectrum. The rays too short to be seen (right) are ultraviolet light. Infrared rays (left) are too long to be seen.

"Cheerful" pink fluorescents made employees in a Florida radio station flip until white ones were restored.

Mice born of parents kept under pink fluorescents lived half as long as other mice.

Waiters in a Chicago restaurant with predominantly "black" light had better health records, were more efficient.



An arthritis victim who broke his sunglasses discovered that going without them improved his condition.

ciency, a weakening of the body's defenses, and an aggravation of chronic disease."

Sunlight deficiency goes far beyond that, however. Dr. Ott, who is chairman and executive director of the Environmental Health and Light Research Center in Sarasota, Fla., reported in *The Optometric Weekly:* "We are just beginning to find that light entering the eyes, in addition to vision, stimulates activity in both the pituitary and pineal glands and possible other areas of the mid-brain region that control the endocrine system and the production of hormones."

The light you "see" is the area in the middle of the total spectrum. At one end are waves too short to be seen—the ultraviolet. At the other end are those too long to be seen—the infrared. There are even shorter and longer types of radiant energy beyond the ultraviolet and infrared; and in all probability they have mild to significant influence on the human organism.

Dr. Ott became interested in the effects of artificial light while doing time-lapse photography—taking pictures at regular intervals of something that changes very

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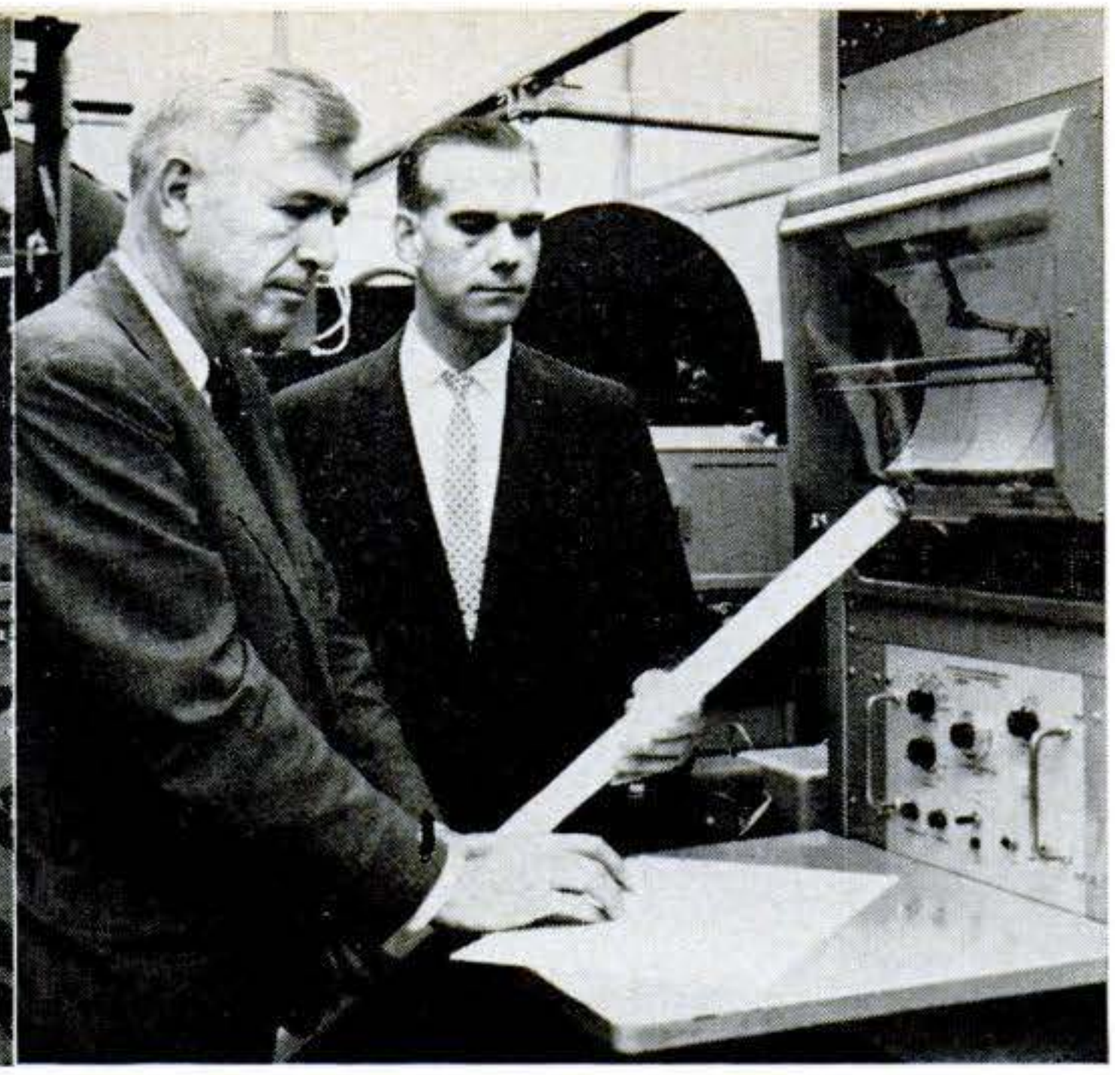
Dr. John Ott, in photo taken some years ago, is shown doing time-lapse photography, which first revealed clues that natural light affected many aspects of life and growth in man and animals.



New Vita-Lite Dr. Ott (left) helped to develop is seen above. The lamp produces the full spectrum that you get in natural light and is designed to give indoor dwellers needed quota of ultraviolet rays.

slowly, like a growing plant, an opening flower, the actions in a living cell. It may take a year or more to complete the photography.

When the pictures are projected in sequence on motion-picture film, the viewer can rapidly see growth or change that may have extended over a year. A bud will swell in the time it takes to blow up a balloon.

Although curious about why some plants bloomed while others didn't, Ott's first significant clue to the phenomenon turned up while photographing the growth of a pumpkin plant for Walt Disney's *Secrets of Life.* To give more light to seeds growing under a skylight in a basement studio, he added ordinary fluorescent fixtures with cool-white tubes. These give light rich in the orange to pink part of the spectrum; women like them because they make cosmetics look redder.

The uncooperative pumpkin. Pumpkins develop both male and female blossoms on the same vine. Both types of blossoms appeared on Dr. Ott's vines, but the female buds turned black and dropped off. Result: no pumpkins.

Dr. Ott tried again the following year. But since the old fluorescent lamps were beginning to flicker, Ott replaced them with new ones of daylight white that gave off a slightly bluish light. The choice of the new lamps was accidental.

This time the female buds developed normally, while the male buds withered and dropped off. But on plants grown under natural sunlight both genders of blossoms were healthy.

In another study, Ott attempted to take time-lapse photographs of the growth of an apple from bud to maturity. He rigged a scaffold beside an apple tree, with a healthy branch enclosed in a box with a glass skylight on top and automatic shutters that would close off external light whenever a frame was exposed on the motion-picture film.

All seemed to be going well; the apples on the photographed branch grew beautifully. But by fall, when other apples on the tree had turned red, the ones in the box remained green—immature.

He tried again the following year. Results were the same until, in desperation, he substituted ultraviolet-transmitting plastic for the glass in the overhead skylight. In a few days the apples had matured and turned red.

Other investigators have found that when you block any part of natural sunlight's spectral energy from entering the eyes of many insects, abnormal growth may result.

If natural light affects the health and growth of plants and insects, as it does almost without exception, some scientists

[*Continued on page 204*]

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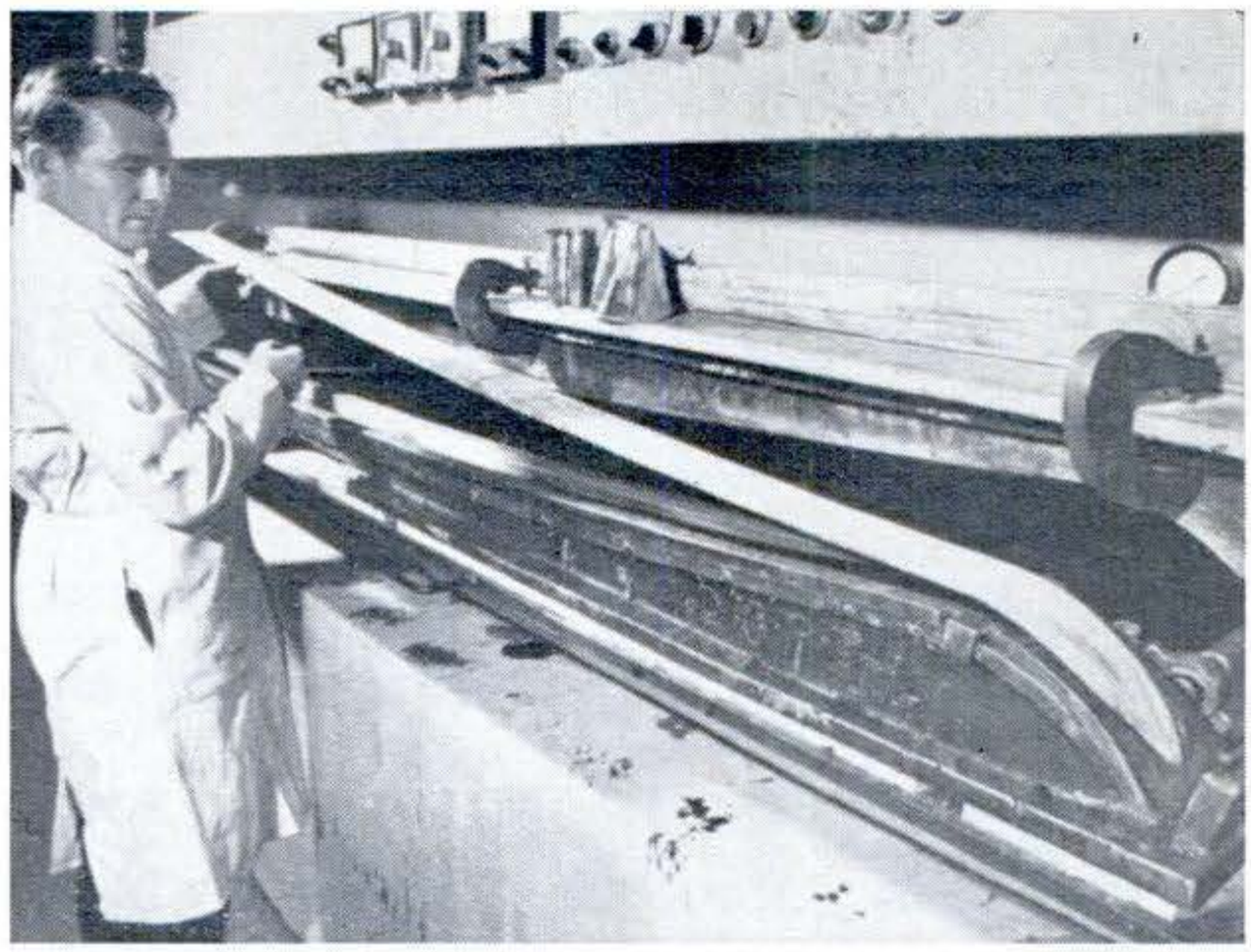
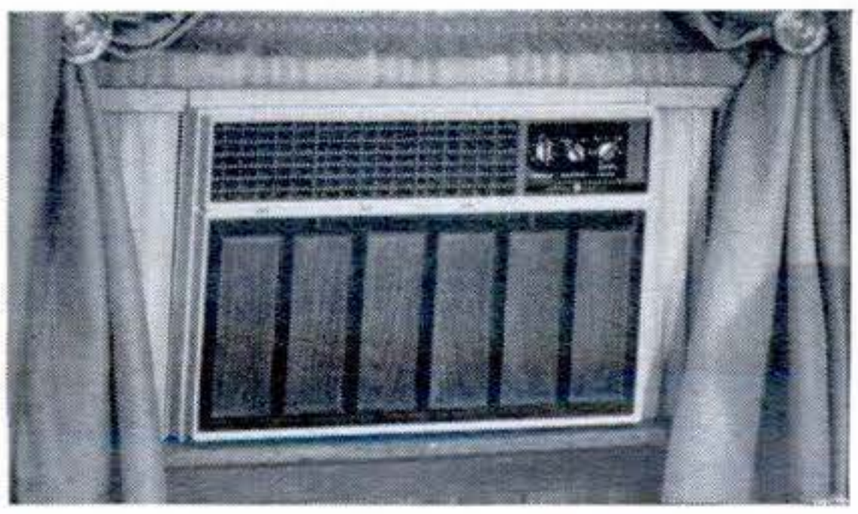
Alarm watch for skin divers

An underwater alarm watch, the Polaris sets off vibrations that can be felt on your wrist and heard clearly underwater. The watch is self-winding and has luminous hands and dial. It's been tested to depths of 600 feet. Made by the LeCoultre Watch Co., it's $180.



Ski with foam center makes sportman's life soft

A skier makes a turn (right) on AMF Voit Spectra skis, which use no wood. The skis have a polyurethane core covered with fiberglass in a computer-controlled process (above). The fiberglass is wound in a figure-eight pattern around the core. Voit claims the design makes them five times stronger than other fiberglass skis. Price: $135.



Charcoal-filter air conditioner

GE's new Fashionaire is said to be the first room air conditioner with an activated-charcoal filter to help screen unpleasant odors from the air. Air is first drawn through a foam-type filter to remove solid particles, then through the charcoal filter before being cooled.

Weathertight shelter setup is a snap

The all-season Porta-Shell is made of fiberglass sections that can be assembled in about 10 minutes by snapping parts together. They're made in sizes varying from 40 to 112 square feet, by Unique Products Engineering, Nashua, N.H. 03060.

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Reporter Gannon, right, gets preflight briefing from pilot Ed Mahler on the stunts they'll do—the four maneuvers shown, with their fine points, in the drawings opposite.

A champion stunt pilot takes me for MY WILDEST AIRPLANE RIDE

Our do-anything reporter braces himself to try rolling, looping, and the fearsome hammerhead stall—and finds aerial acrobatics just his dish

By ROBERT GANNON

I was in the rear seat of the plane, waiting for pilot "Big Ed" Mahler to show me firsthand what stunt flying is like. And I was very uneasy. You might say petrified.

It was cool outside at Princeton Airport, N.J., but the air in my tiny cockpit seemed close and stifling. I checked to

Continued

In AT-6 plane's back seat, Gannon gets set for ride—"petrified," but not too much so to see that his parachute harness is properly adjusted, just in case.

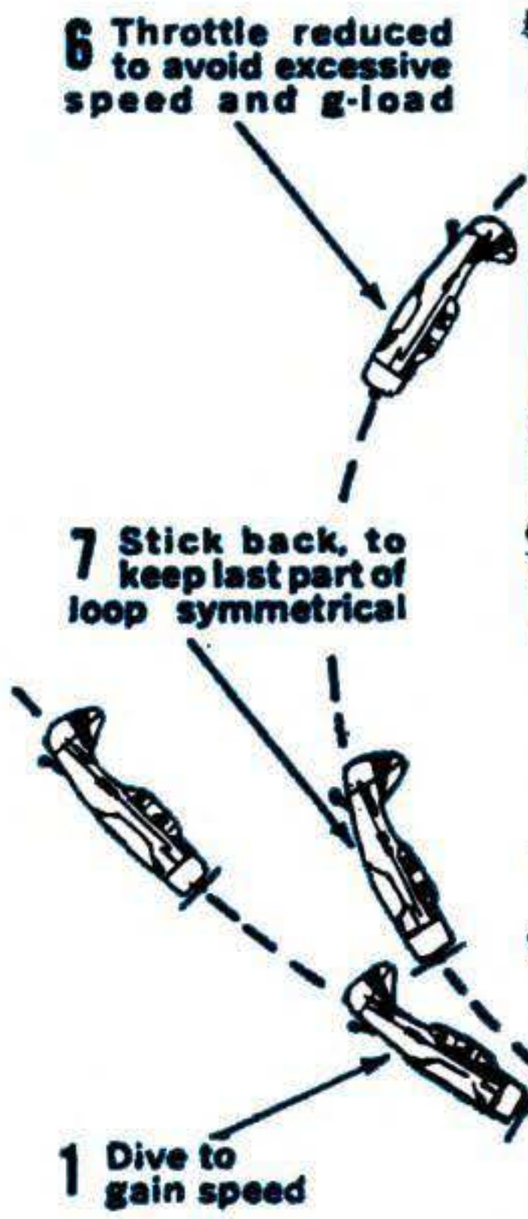
SLOW ROLL

Striking maneuver rotates plane this way. The more slowly and smoothly it's done, the more skill it takes.

SNAP ROLL

Sudden and jerky compared to slow roll, this maneuver whips plane over by own momentum, after abrupt application of controls. With standard plane, a goof in timing could yank loose a control fitting, pop rivets, or crack the windshield.

LOOP



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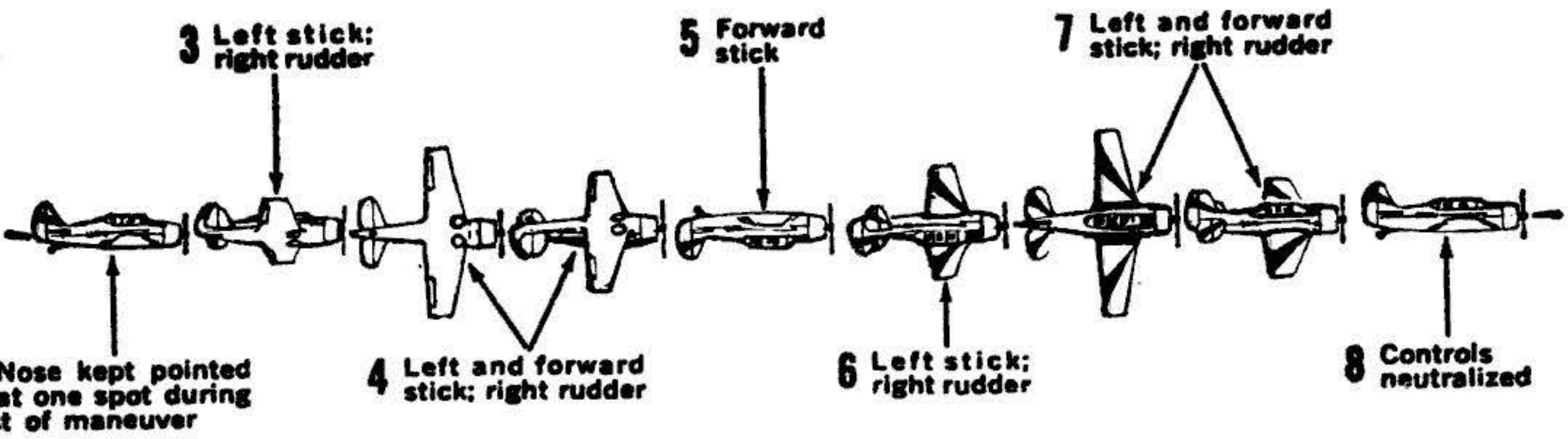
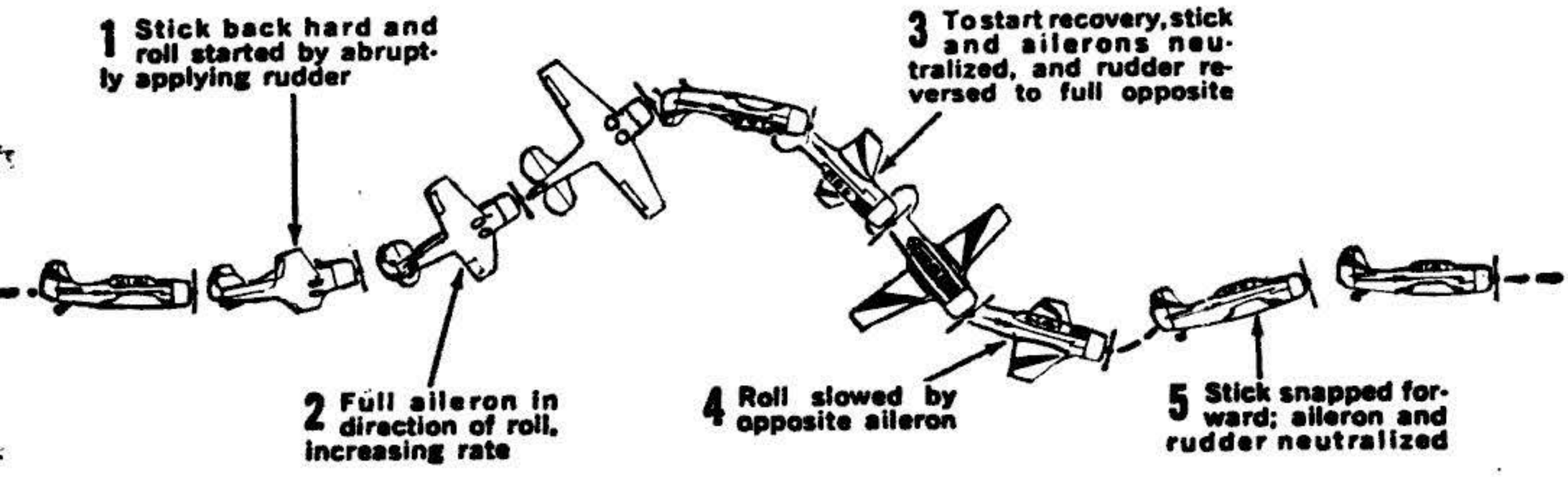
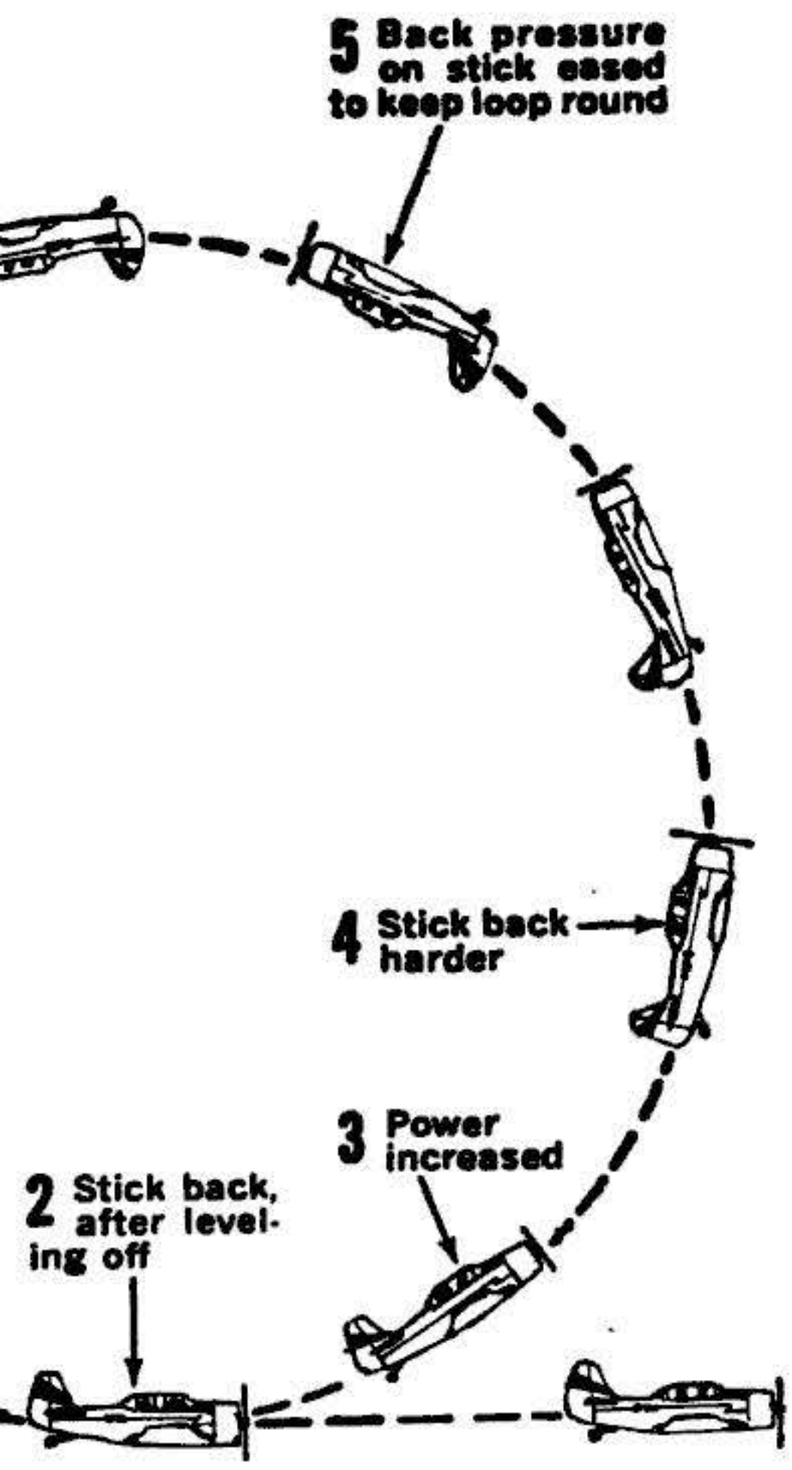
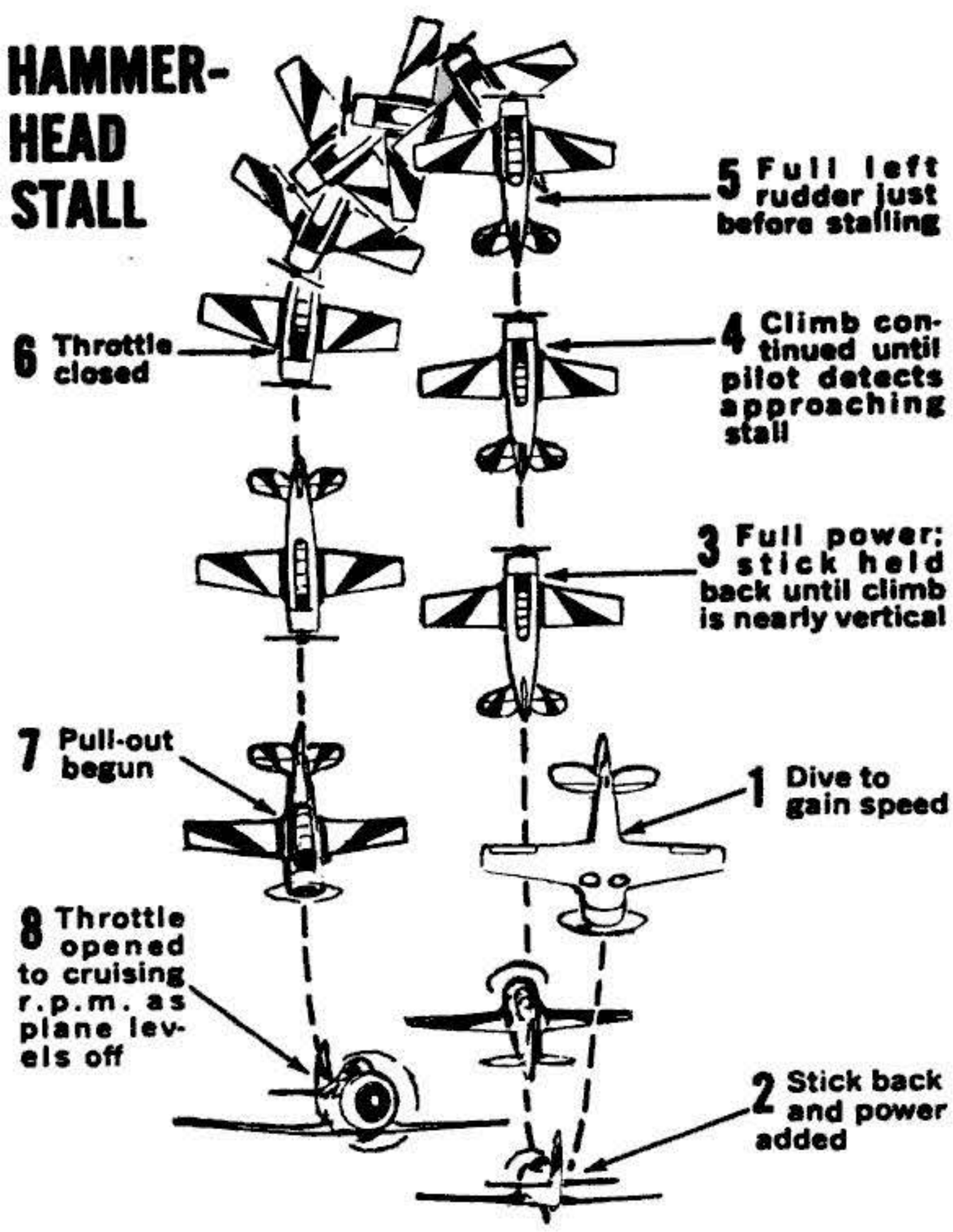






Classic maneuver looks simple in principle—but making perfect circle, rather than oval or half-moon, takes some doing.



Tipping over sidewise, from nearly vertical climb into a dive, calls for critical timing with rudder—or else.

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"For an instant it seemed terribly important—the preoccupying puzzle

see that my safety belt was secure—I might be straining it. I noted where I could grab the plane's rib tubing—and made sure I could open the sliding overhead canopy in case I got airsick. I adjusted my parachute pack.

What I was to try—aerial acrobatics, or aerobatics for short—is a vanished art for the conventional flier. (An airplane is considered to be in aerobatic flight when it dives or climbs at more than 30 degrees, or a bank exceeds 60 degrees.) A student pilot no longer is required to spin his plane during his license exam. Rare is the pilot who has ever flown upside down.

And it's a shame, a stunt flier will tell you. Most pilots haven't the foggiest notion of what happens when you use full rudder, elevator, or ailerons. But a pilot trained in aerobatics knows what a plane will really do. In an emergency—say, if he gets caught in the blast of a jet just as he's landing—the ability to use controls to the fullest may save his life. Besides, I was to learn, tumbling around the sky is fun.

The motor churned, backfired to life, and roared. As we took off, the AT-6, left over from World War II, shook like a Jeep tearing down a railroad track.

Behind, the strip shrank. On a panel in front of me, an airspeed indicator registered 160 m.p.h. Big Ed, ahead of me and partly hidden by the tubing, turned half around and yelled something. "Huh?" I yelled back. He repeated whatever it was, and I just nodded, giving up trying to hear him above the roar.

Doing a slow roll. Suddenly the engine changed pitch. The horizon tilted and slipped up the side of my vision. Then I was upside down, dangling by my seat belt. My hands grabbed the struts in an overwhelming "hang-on" reaction, and I was experiencing an amazing preoccupation with the puzzle of where was up. For an instant that seemed terribly important. And then the horizon slid down on the opposite side, and we settled down to normal flight.

We had done a slow roll. I was happy I wasn't in an open-cockpit plane.

The roll, in theory, is a simple maneuver. You use the ailerons to roll, and the rudder and elevator to keep the nose straight. But a pilot has a tough job holding direction and altitude—particularly if the roll is done slowly and smoothly, as Mahler did it. The problem is that when you're on your side, you use your *rudder* to keep the nose horizontal, and the elevator to eliminate side movement. And when you're upside down, the rudder and elevator have an effect opposite to normal.

The little world of stunt flying—and one of its stars

"Big Ed" Mahler does aerial acrobatics for profit, prizes, and the fun of it.

Some 250 pilots around the country help keep the art of stunt flying alive. That is the number who enter at least one of a number of aerobatic meets held yearly, estimates "Pappy" Spinks, president of the Aerobatic Club of America, which sponsors the competitions.

One of these, and a champ at it, is Ed Mahler. Most of the time he works at designing machine tools for a New Brunswick, N.J., scientific-equipment firm. But on weekends he's looping, toppling, spinning through the air—performing in air shows for extra income, entering competitions for prizes, or just twirling around for the fun of it. On the aerobatic circuit he's known as "Big Ed," six-feet-four of him at 35 years.

He got into the sport in 1953 when, learning to fly, he found he enjoyed doing things "a little out of the ordinary" with a plane. He bought an old PT-19 and a couple of books on aerobatics. He'd practice a stunt on the ground until control movements became almost automatic; then, over and over in the air, at 5,000 to 6,000 feet for plenty of room, until he had it right. (Acrobatic flight below 1,500 feet is illegal unless a

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of where was up"

Gannon's pen seems to fly upward and his notebook follows it—but that should hardly be surprising with his plane bottom side up, as pictured during his flight. Few pilots today have ever flown upside down, but author did in slow roll, snap roll, and a loop, as he tells here.

Next—a snap roll. I was still trying to figure out what had happened when Big Ed turned and shouted again. This time I caught the words: "Snap roll."

You go into a snap roll quickly from a climbing start—"snapping" the controls to spin the plane. You enter a high-speed stall. But the plane continues to revolve because of its momentum. Unlike a slow roll, it's jerky, especially for someone hanging on for dear life in the back seat. Me.

The maneuver went too fast for me to sort out the sequence. The horizon slipped up again, then suddenly disappeared as we flipped over. The plane shook as though flying apart. I was slammed first to one side, then to the other, and then we were level again. It was rough but exhilarating, and beneath the thunder of the plane I noticed I was laughing out loud.

Could you do such a thing in an ordinary plane—a J-3 Cub, say, or a stock Aero Commander? Some pros do, but they've had extensive training in planes especially designed for stunting. A timing goof during that snap roll could stress a standard plane enough to yank loose a control fitting, pop rivets, crack a windshield. Further, inverted flying would cause trouble with conventional, delicately balanced instruments, and even with the battery—acid could run out the top air holes.

Good loop is round loop. "Loop!" shouted Big Ed. Here was the classic, the maneuver I remembered from my days of model planes of balsa. You might think it the easiest maneuver in the book—all you do is hold back the stick, using ailerons and rudder only for trim. But it takes skill to make the loop

[Continued on page 206]

professional performer gets an FAA waiver.) His PT-19 has since been replaced by a PJ-260 (photo at far left) that he built himself, with a mechanic friend, and his two-seater AT-6, a military trainer that he picked up for a bargain $700 as Navy surplus.

Today he's flying for one event or another nearly every weekend. His fanciest stunts range from giant square-cornered loops, and a head-over-heels forward tumble called the "lomcevak" (Hungarian for headache), to a hair-raiser called a ribbon pick-up: He roars earthward, flips upside down, edges lower and lower—and, with the propeller, cuts a paper ribbon strung between two poles before rolling upright again.

In aerobatic competitions each pilot must fly three groups of maneuvers. One is a standard course of 17 (photo at right). Another is given to the pilots a day before the meet, with no practice allowed. The third group is made up by each competitor. Last August the largest American competition ever was held at Rockford, Ill. Twenty-nine fliers entered, and Ed Mahler came out on top in the unlimited class.

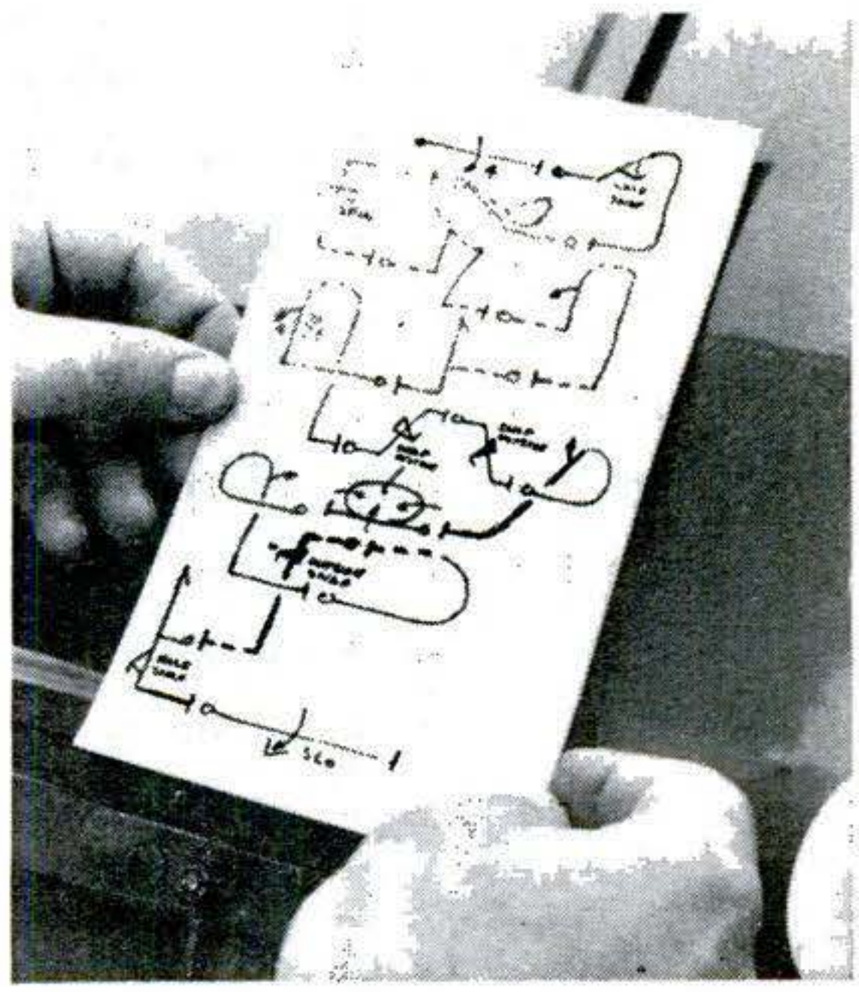

Chart prepared beforehand shows series of stunts to be done in a competition.

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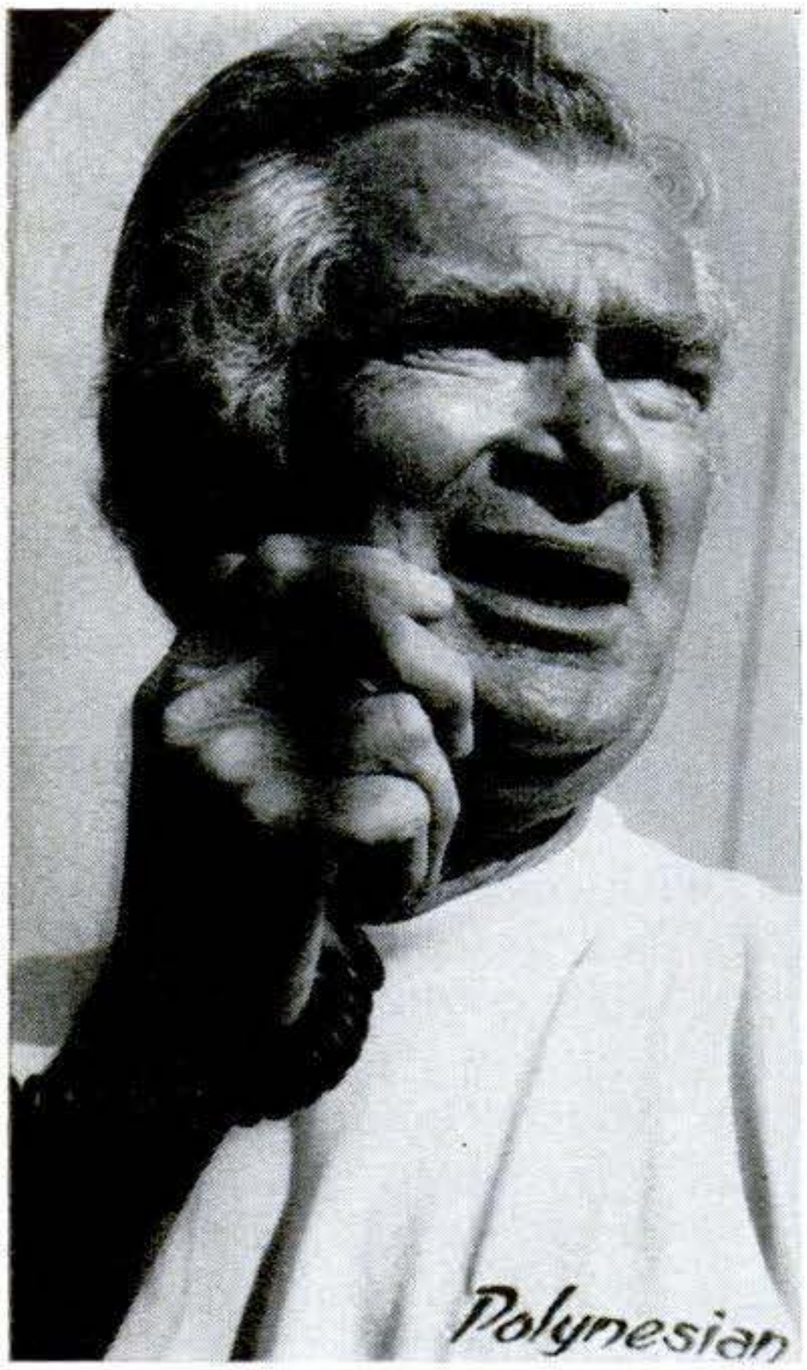
Sail with Buddy Ebsen on a



NEW BREED OF RACING CATAMARAN

Here's a behind-the-scenes look at the multihulled beauty the famous star of TV's "Beverly Hillbillies" built and raced to victory across the Pacific

By BUDDY EBSEN

TV-star Buddy Ebsen aboard Polynesian Concept radios in for pre-race compass check. Cat is named for first multihull sailors.

I'm a cat-fancier—not of the animal kind, but of catamarans, the fastest sailboats in the world. There's more laughter on them, and excitement—and that's what makes them irresistible to me.

My love of cats spurred me to build a winner that I call the Polynesian Concept. It took two full years to complete in spite of my more than 40 years of experience with conventional hulls. I was lucky, though, to have Rudy Choy, one of the best marine architects and catamaran builders in the world, design my boat.

I was also lucky to get the ideas of Juergen Wagner, who sailed his 43-foot ketch, the World Cat, 30,000 miles around the globe. I asked Wagner and Holger Rahlff, his one-man crew, to tape-record any problems they had at sea and send me the tapes from each port.

The hull. One of Wagner's first suggestions was to build a symmetrical hull. His own asymmetrical-hulled craft convinced him that a symmetrical design would cut hull banging in choppy water. He told us, too, to decrease stringer spacing from 12 to about eight inches, and increase stringer size from one to 1½ inches. In other words, build in more structural

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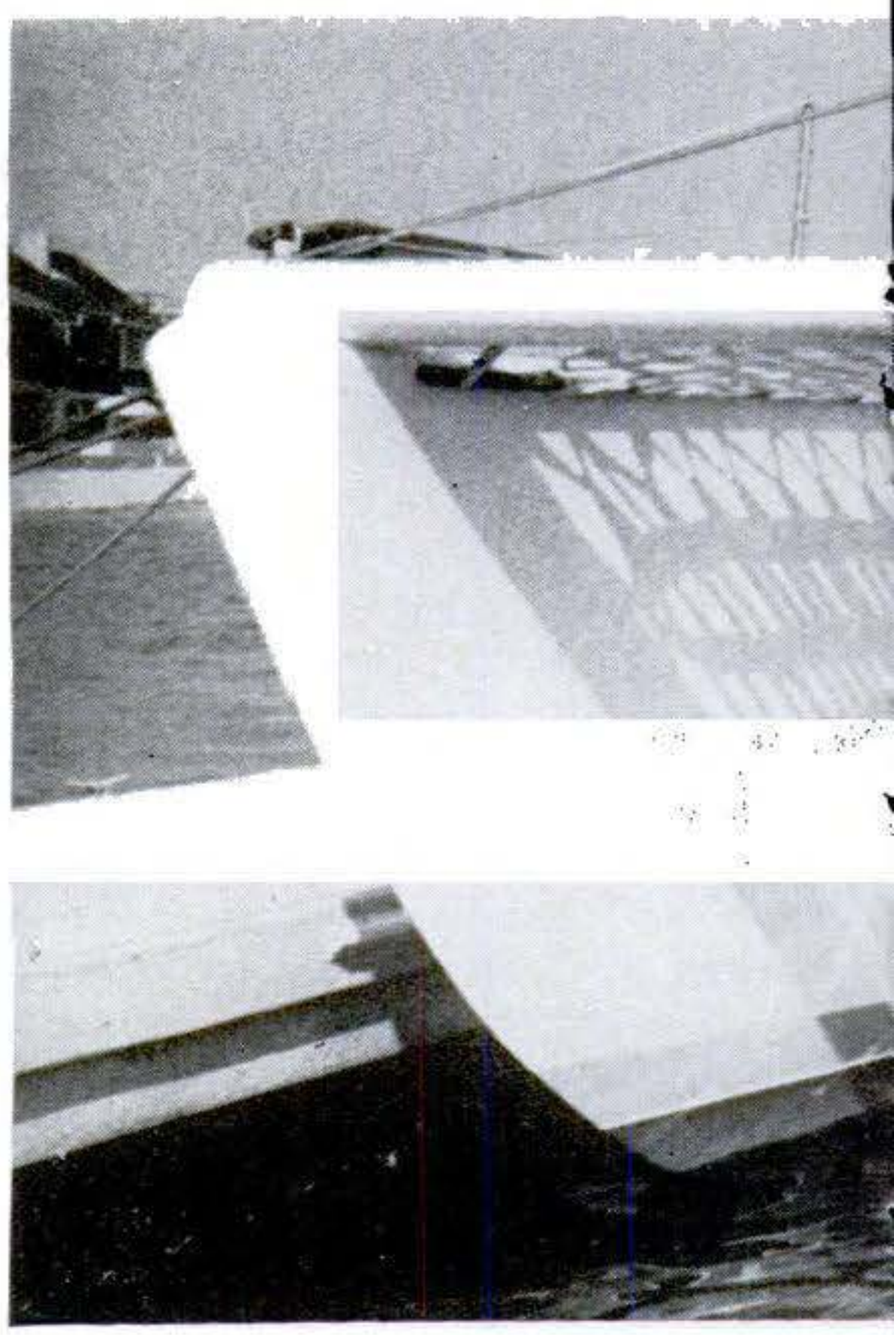

Overhead trampoline (for exercise

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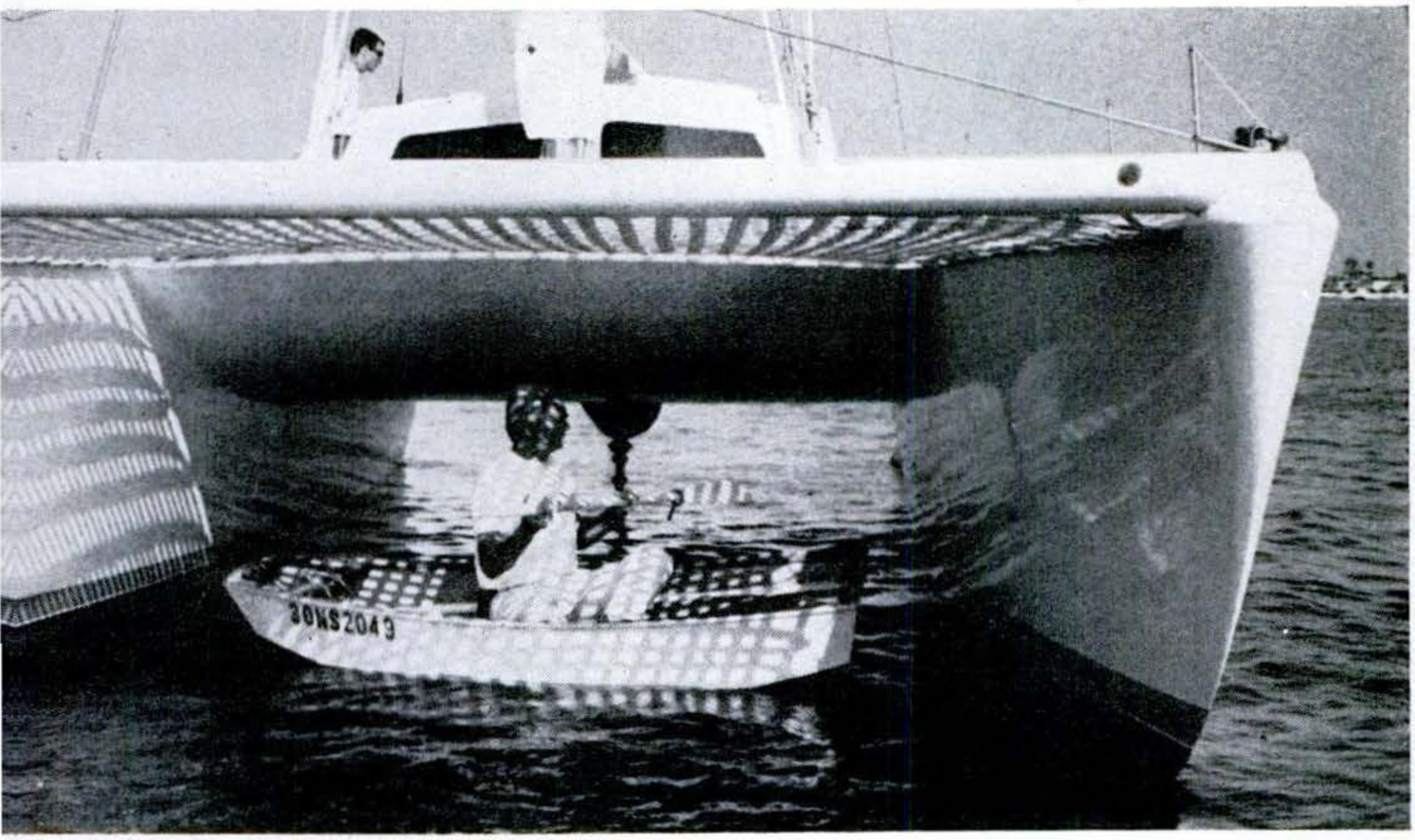
Polynesian Concept with a fair breeze in its sails is shown at the moment it crossed the finish line—about 1:12 a.m.—at Diamond Head in Hawaii. It traversed the 2,225 miles from San Pedro, Calif., in a grueling 12 days to finish first—the smallest cat in the race.



ıon long voyages) casts shadow grid over Ebsen as he checks understructure of craft before race.

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strength to withstand sea pounding.

Wagner's experience with 60-knot gales near Tahiti also convinced us to overbuild the mast. Made to order in London, it's 44 feet high and all aluminum, including a winch fitted into the mast itself. If the boat goes over, we can release the $1,300 mast and float the P.C. upside down.

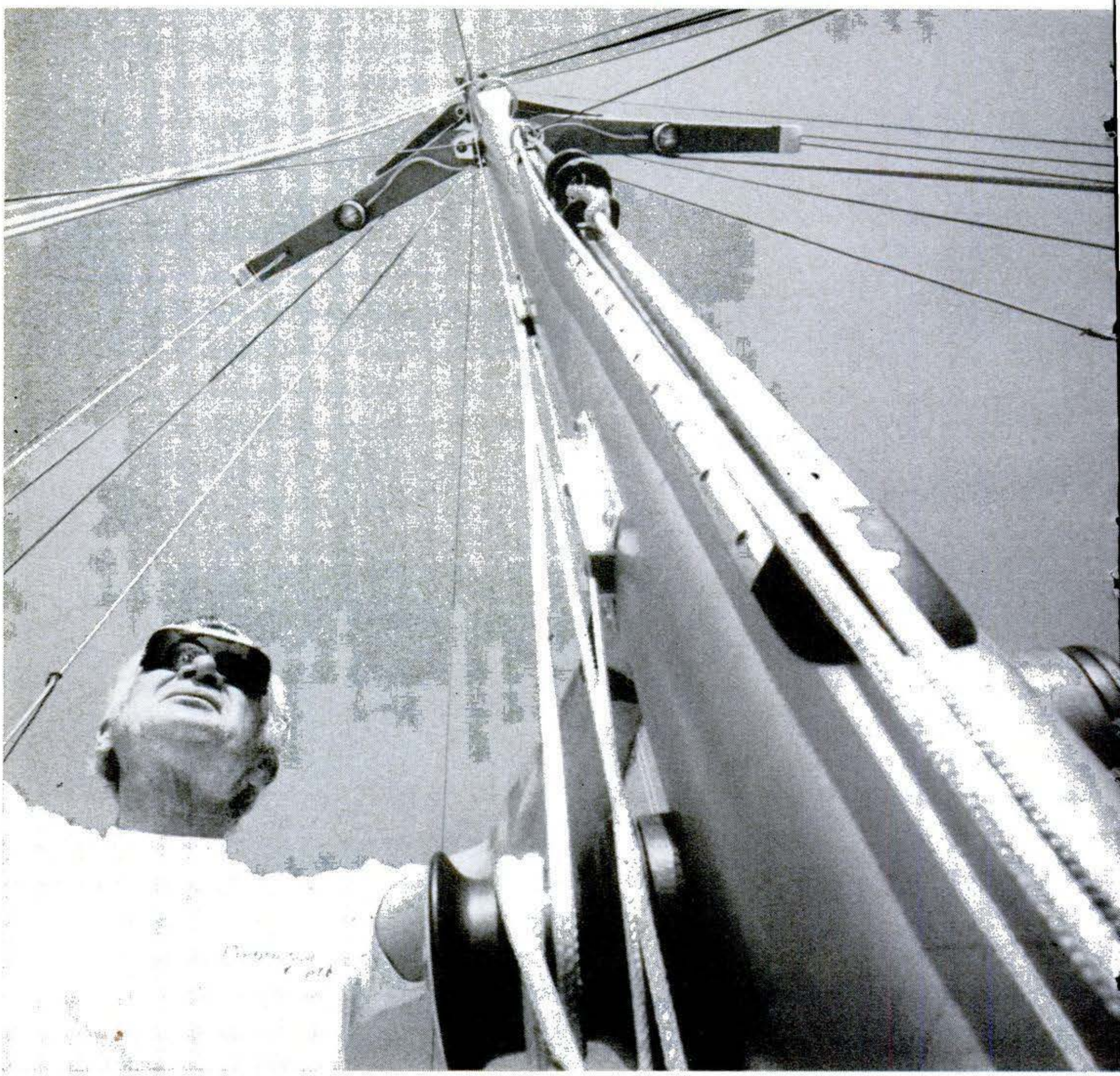
Rudy and I picked a knife-edge hull design. The P.C.'s green-bottomed hulls are connected by a wing-bridge shaped much like an airplane wing. They're narrow, with just about no flat surface, and deep as heck. They have to be deep to get the living space needed to carry a six-man crew and a lot of supplies. And you get more floatability.

The sails. That's another thing I'm proud of—the small amount of canvas that we carry:

- Mainsail: 500 sq. ft.
- Jibs: No. 1, 500 sq. ft.; No. 2, 393 sq. ft.; No. 3, 225 sq. ft.; storm jib, 104 sq. ft.
- Spinnakers: No. 1, 0.75-oz. nylon, 1,300 sq. ft.; No. 2, 1.2-oz. nylon, 1,300 sq. ft.; No. 3, 1.5- and 1.2-oz. nylon, 1,065 sq. ft.; No. 4, 1.5-oz. nylon, 850 sq. ft.

There's also a long-shanked 22-hp. Johnson outboard for auxiliary power. It gives a speed of 8½ knots.

Scanning skies with weather eye, Ebsen grips the 44-foot-high detachable aluminum mast.



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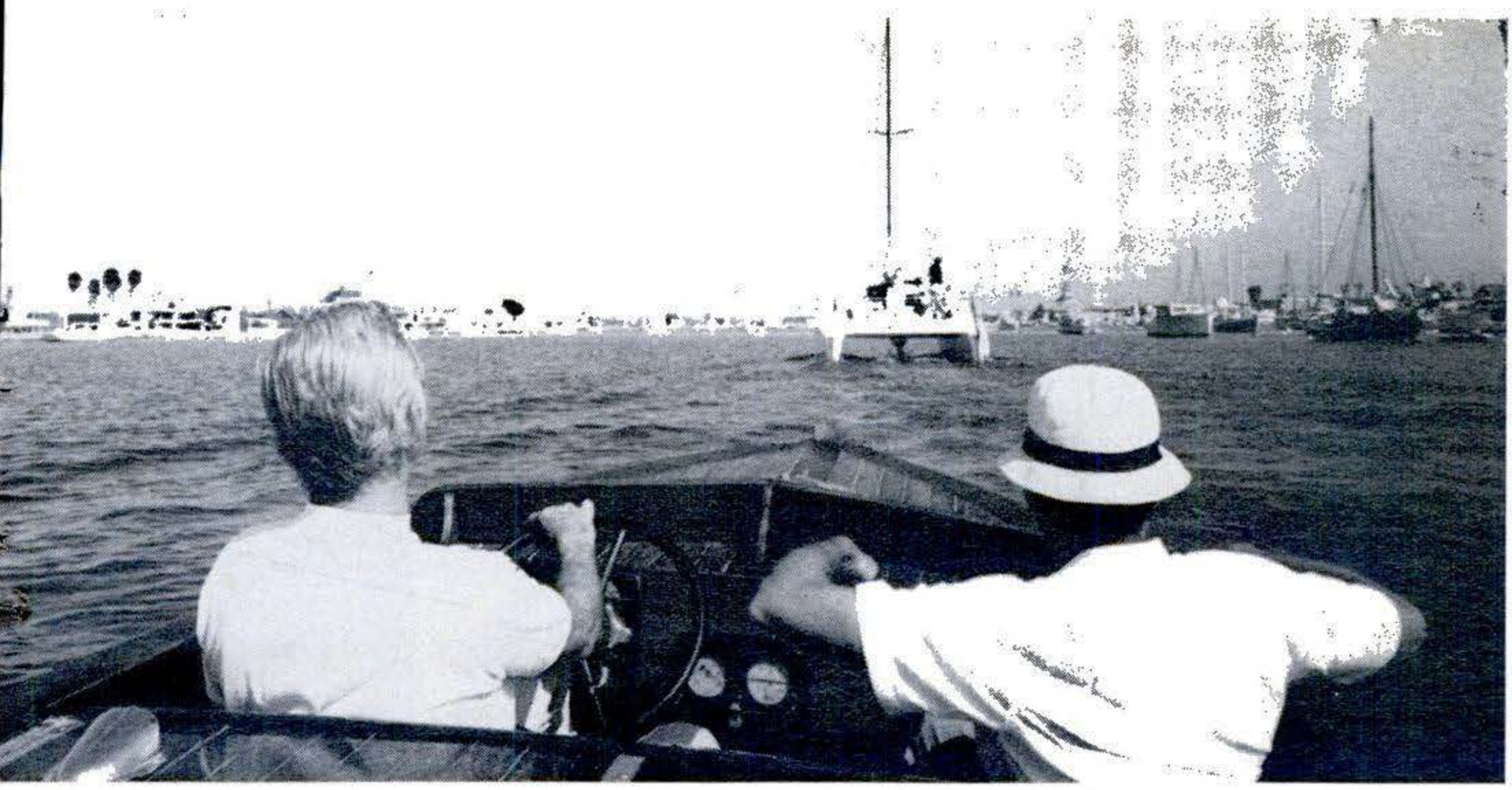


Riding behind the P.C., Ebsen and crewman observe craft's performance under auxiliary power.

The Polynesian Concept is 35 feet, three inches long and 16 feet, six inches wide. She weighs 5,500 pounds and has a 19-foot draft. There's a head, a galley, and sleeping quarters for six.

How it all turned out. The first big test for the P.C. was a race off Catalina Island. No one on the dock thought our baby could sail to weather. But we crossed the starting line with a fair breeze in our sails that pushed us past the bigger cats at 12-knots-plus, and we ended up second.

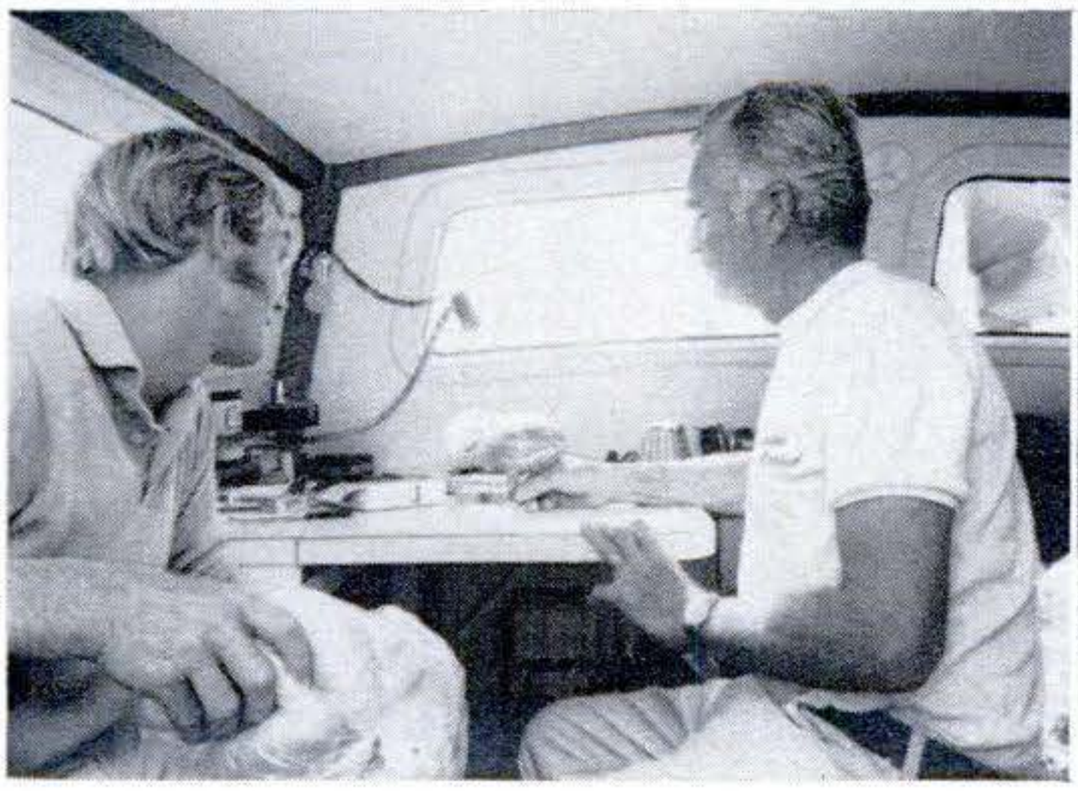
This was just a warm-up for the Third Biennial Multihull Transpacific Yacht Race from San Pedro, Calif., to Diamond Head, Hawaii. The P.C., smallest cat in the race, got a 37-hour handicap.

Three crewmen handled the craft at a time, standing a four-hour watch. We were at sea almost 12 days and crossed paths with a close competitor—the Lani Kai—twice. One night we passed them and fled, but next day she outran us. The following night, the wind blew out her spinnaker and we showed her our fantail.

Rain squalls hit us at least half the nights on the trip. It got so that we actually started looking for them to take advantage of their added push.

It was a long battle—a distance of 2,225 nautical miles. But even though we were the smallest cat in the race, we came through with the best time—the official winner.

And now, more than ever, I'm in love with a cat. PS



Crewman Holger Rahlff (left) and Ebsen check inventory of food and equipment they carried.

Man-overboard drill: Tiller box with roped-on life jacket, light, and marker buoy is heaved over side.

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Granulated cork and rubber, confined in shell, form ball core.

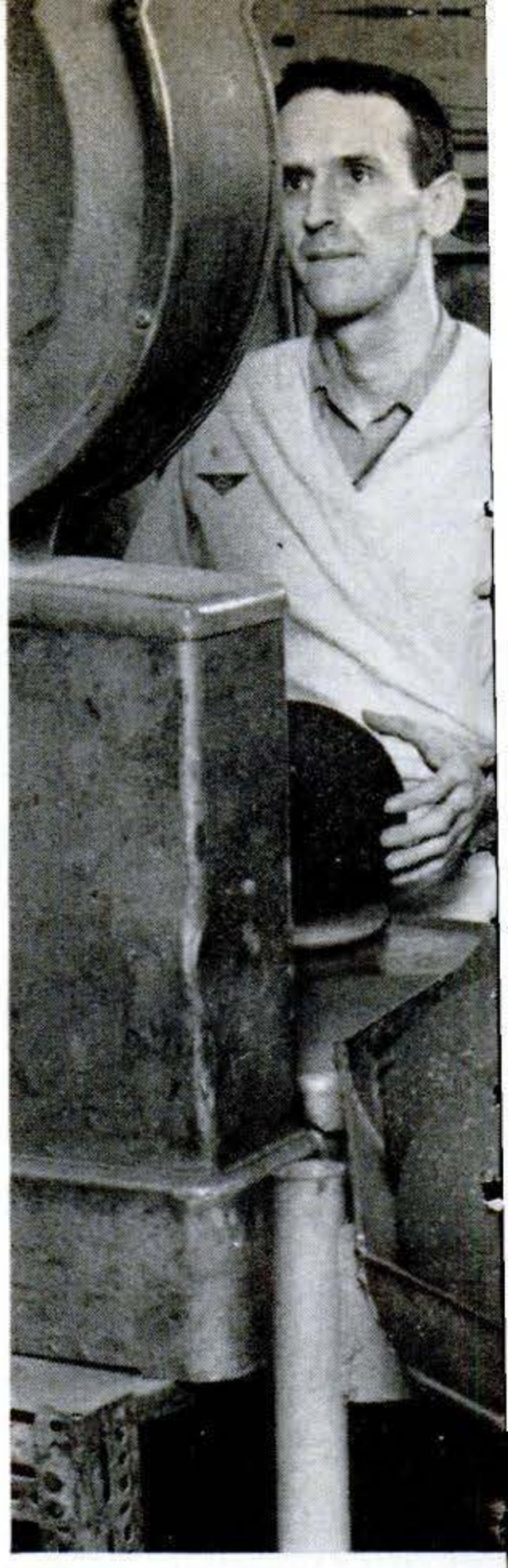
Partially compacted ball of ingredients at left looks like this.

Elongated ball with covering shells is now ready for oven curing.

After curing at high temperatures, inner core's cover is sealed.

Roughing up the inner cover readies ball for its smooth outer skin.

Outer cover is molded onto core and seam is then ground down.



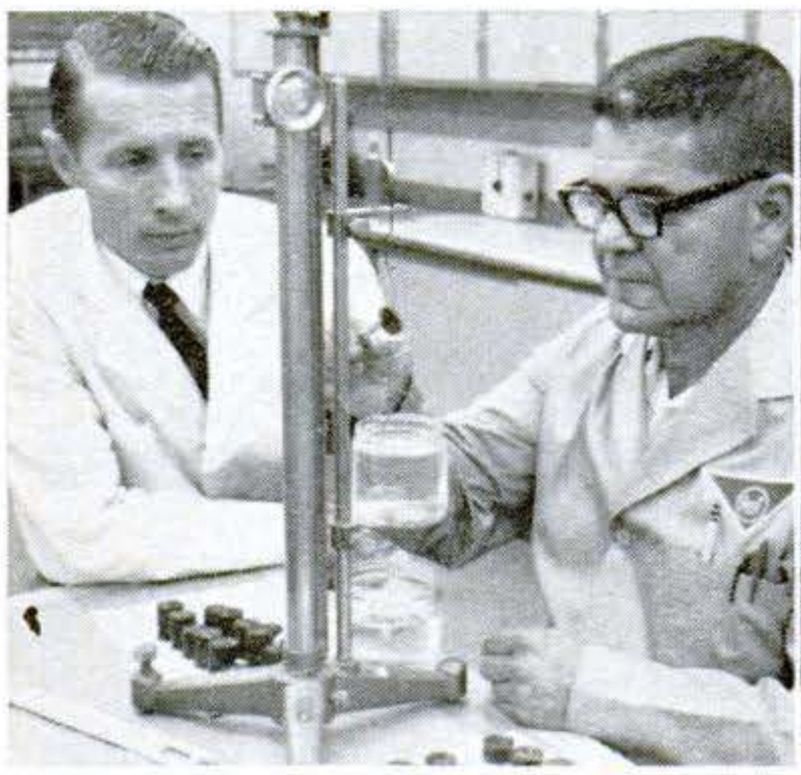
Champion Dick Weber (at

Rolling out a new BOWLING BALL

Here's a step-by-step look at the way they make today's

Many bowlers agonize over blowing a spare when their ball just misses knocking down one pin by a whisker. Because champion bowler Dick Weber occasionally experienced the same disappointment, he looked for a solution to those near-hits. And he's come up with something that may up the score and cheer the hearts of many keglers.

His solution—a ball with ¼-inch great-



To achieve balance, weights of all materials that go into each ball are precisely determined. In photo at left, Weber watches as technician checks specific gravity of bowling-ball cover stock. Core is molded in compressor (center). Later the core is cured in an oven (photo at right) under great pressure.

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enter) examines core about to be weighed before it goes into compressor (rear) to get outer skin.

ounder and bigger bowling balls—from the inside out

er diameter than minimum American Bowling Congress specifications. Convinced that the extra fraction in diameter would knock down pins that wobble, yet refuse to fall, he went to the AMF Company and asked them to produce the ball.

Here's how AMF undertook this precision engineering job—and an inside look at the complex process that resulted in its new Dick Weber all-pro ball.

Core gets its smooth hard-rubber skin after curing, and ball is then placed in centerless grinder (left) for finishing. Next step is marking exact center of gravity (center photo) so fingergrip holes can be drilled in precise spots for perfect balance. At right, the finished ball is checked for hardness.

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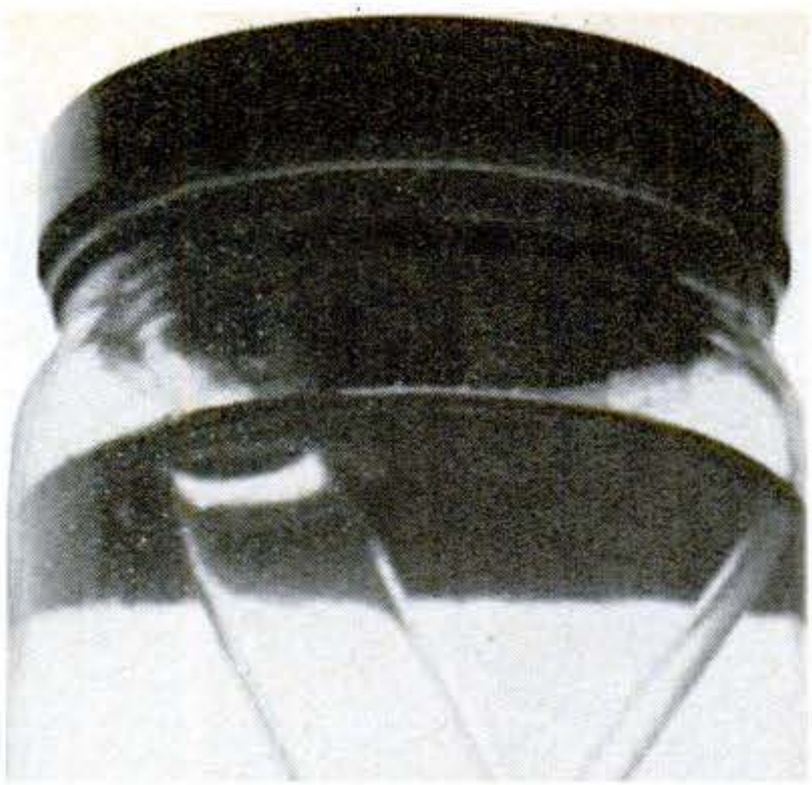
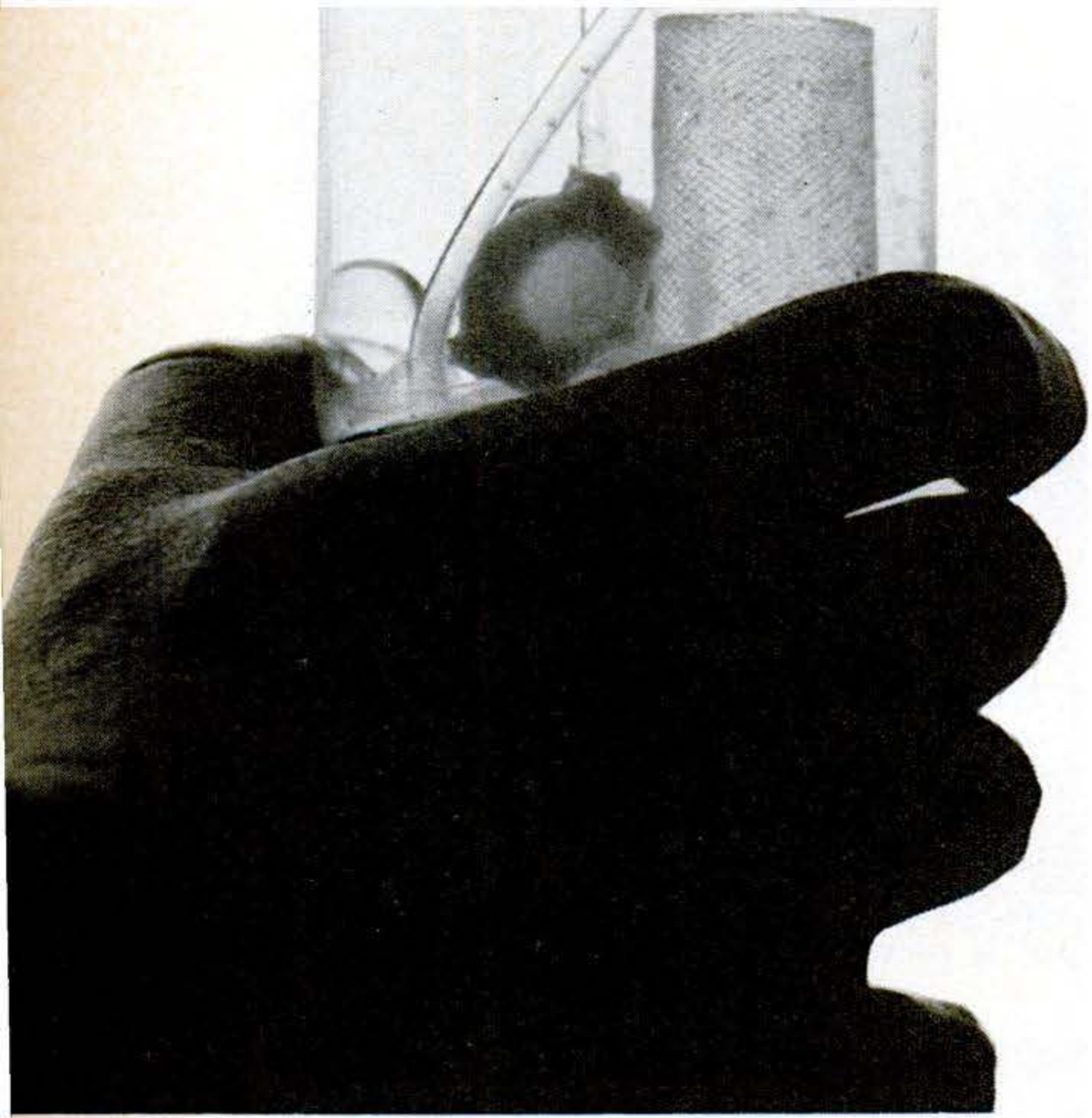


Nonfogging properties of Hydron-coated glass are demonstrated by directing steam jet at panel. The coated center remains clear, while edges fog up.



New parts for human body are the most promising uses for chemically inert Hydron. In water-filled bottle above are prototype heart valves, tendons, esophagus, arteries, and a common duct.

HYDRON:

Flexible when wet, this weird material may make new parts for the human body, nonfog goggles and car windows, chewing gum—you name it

By THEODORE IRWIN

At the end of your fishing line is an irresistible new lure. Molded to the shape of a crawfish, minnow, or hellgramite, it gives off a strong bait smell. Since fish are attracted by both odor and sight, you can expect to haul 'em in.

Or let's say you're skiing and your goggles suddenly fog up dangerously. (It happened at the last Winter Olympics to the top Austrian skier when he missed the gate on the Giant Slalom and was disqualified.) Specially treated nonfog goggles are now available.

Even more important may be nonfogging car windows. Based on the same principle as the goggles—a moisture-absorbing plastic coating—they're now being investigated.

Both the lure and the goggles involve an extraordinary new "soft" plastic called Hydron. The goggles are coated with it, and Abercrombie & Fitch, the New York sporting-goods store, has said it will need many thousands of pairs this year.

A wide variety of interested U.S. companies are researching possible consumer applications. As a result of their efforts, things you use, the food you eat, clothes

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Nonfog goggles are demonstrated by Dr. Thomas Shepherd, president of Hydron Laboratories. In addition to goggles for skiers, versions for hunters, baseball players, and scuba divers are planned. This is one of many uses for the plastic, which can be made in variations, each with its own properties.

new miracle plastic with a myriad of uses

you wear, and even medical devices and body "replacement parts" may sooner or later contain Hydron, although large-scale marketability of products developed has yet to be demonstrated.

It's water-loving. Technically, Hydron is classified as a hydrophilic acrylic polymer. That means it's water-loving (hydrophilic), has an affinity for wetness; a synthetic derivative of metacrylic acid (acrylic); and a member of the plastic family (through the chemical process of polymerization). In the original state, it's a hard, transparent material that can be cut, ground, or molded into any shape. Put it in water and the stuff becomes soft and pliable. Let it dry and it reverts to its former hard shape.

These and other unusual properties set Hydron apart from ordinary plastics. Most other plastics are hydrophobic, repelling water. With Hydron, water swells its molecules and the molecular structure can be so controlled that a little or a lot of liquid is absorbed. Hydron can encapsulate a drug, flavor, or aroma (as in a fish lure, perfume, or food) and the rate at which the substance is released can be governed by altering the Hydron's chemistry. Being chemically inert, it's compatible with human tissue, based on tests to date, and can be used inside or outside the body.

The value of these characteristics becomes clear when the soft plastic is applied as a liner for dentures. Because water molecules stick to the liner's surface, it adheres firmly and naturally to the mouth's moist tissues, the mucous membrane. Wet, the liner stays soft, resilient, and comfortable.

Contact lenses. Somewhat similarly, Hydron has been hailed by certain leading ophthalmologists as a boon to wearers of contact lenses. Here again, the "memory" of the material is in its wet state. Once the lens has been ground from the hard form of the plastic, it molds itself to the cornea when placed in the moist eye [PS, Jan. '69]. Sale of lenses (and use of Hydron in the body) is awaiting Food and Drug Administration approval as a result of a decision made after publication of the January PS article.

It was contact lenses that first rocketed Hydron into the American orbit. The saga starts with its Czech discoverer, Dr. Otto Wichterle, one of the world's most distinguished polymer experts. A former

Continued

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professor of organic chemistry at Prague's Technical University, he is the founder—and still director—of the Institute of Macromolecular Chemistry.

One day in 1951, on a train from his suburban home to Prague, Dr. Wichterle chanced to glance over at an American medical journal being read by the man seated beside him. An ad for surgical implants caught the chemist's eye. His neighbor turned out to be an eye specialist and a member of a government medical committee. In the ensuing chat, Wichterle blasted the use of a metal, tantalum, as an implant because it isn't compatible in the human body. "Why," he asked, "shouldn't surgeons use something like a soft plastic?"

Invited to address the government committee, Wichterle was bitterly attacked for his views. "I said the material I had in mind could be made," the gaunt, gray-haired chemist recalled recently on a visit to New York.

The requirements. Dr. Wichterle knew his X substance had to have certain essential properties: It should be harmonious in behavior with human soft tissue; include no irritating chemicals; be permeable; and be able to resist enzymes—to remain stable under biological conditions. Finally, the substance would have to attract water, then swell.

To fulfill these conditions, the right kind of molecular structure had to be evolved. It took Wichterle and his assistant, Dr. Drahoslov Lim, more than a year to arrive at their molecular chain, and another year to devise a method of producing it.

Starting with the replacement of eyeballs, the crude form of X began to be used in Czechoslovakia for plastic noses and ears, and as artificial breasts in cancer cases. In 1962, the Czechs ventured into contact lenses.

Late one night in 1964, Jerome Feldman, the forceful, 39-year-old president of an international patent-licensing organization, received a long-distance phone call in New York from a friend in Los Angeles.

"Jerry," said his friend, "an important eye specialist here on the West Coast tells me the Czechs have developed a soft contact lens. You're an expert on Behind-the-Curtain inventions. Ever hear of it?"

Feldman said, "No," and his friend hung up.

Eight years ago, Feldman and his law partner, Martin Pollak, founded a company to arrange patent licensing. They had visited Soviet Russia and its satellite countries to pick up U. S. licenses for hopefully profitable inventions. The day of the West Coast phone call, Pollak happened to be scouting in Europe. A cable sped him to Prague. Ten days later, Pollak was back with a bottle of Czech contact lenses.

Those "soft" lenses were still elementary; American technology could help improve them. After an engineering company was retained to do research, Feldman and Pollak realized that the plastic material might be the key to a variety of new products.

From X to Hydron. From the Czech Academy of Sciences, which owns the patent, Feldman's organization obtained a license for all uses, covering the Western Hemisphere, Western Europe, and the Far East. X emerged as Hydron, from the Greek *hydra* for water. Since then, the plastic has been constantly refined and improved at labs set up in New Brunswick, N. J. American know-how and ingenuity in close to a dozen sublicensed companies is being applied to come up with practical applications.

Hydron's scope seems very wide. Here's a rundown of products currently being researched:

- For clothing. An independent research organization has reported that Hydron can be effective as a soil-release coating on permanent-press garments. A joint research agreement has been entered into with M. Lowenstein and Sons, a major textile firm.
- As a leather substitute in combination with other polymers. Known as Hydrohyde, it's breathable, stretches, and has MVT (Moisture Vapor Transmission). In a raincoat or shoe material, perspiration passes through and permits the skin to breathe.
- Flavors and aromas. Hydron can hold flavors intact indefinitely and re-

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lease them as desired. Before too long, you may be offered Hydron-treated foods, chewing gum, and other items.

- In tobacco. Hydron is being tested for cigarette filters and as a medium for retaining taste. Moisture in the tobacco would free encapsulated flavor.
- In sports. Besides nonfogging goggles for skiing, hunting, and big-league baseball, Hydron-treated goggles for scuba divers will soon be launched by the Woodstream-Hydron Corp.
- For women. Smith and Nephew and Hydron Laboratories are testing Hydron in nail polish, mascara, and other cosmetics. Proctor & Gamble is also researching in certain product areas.

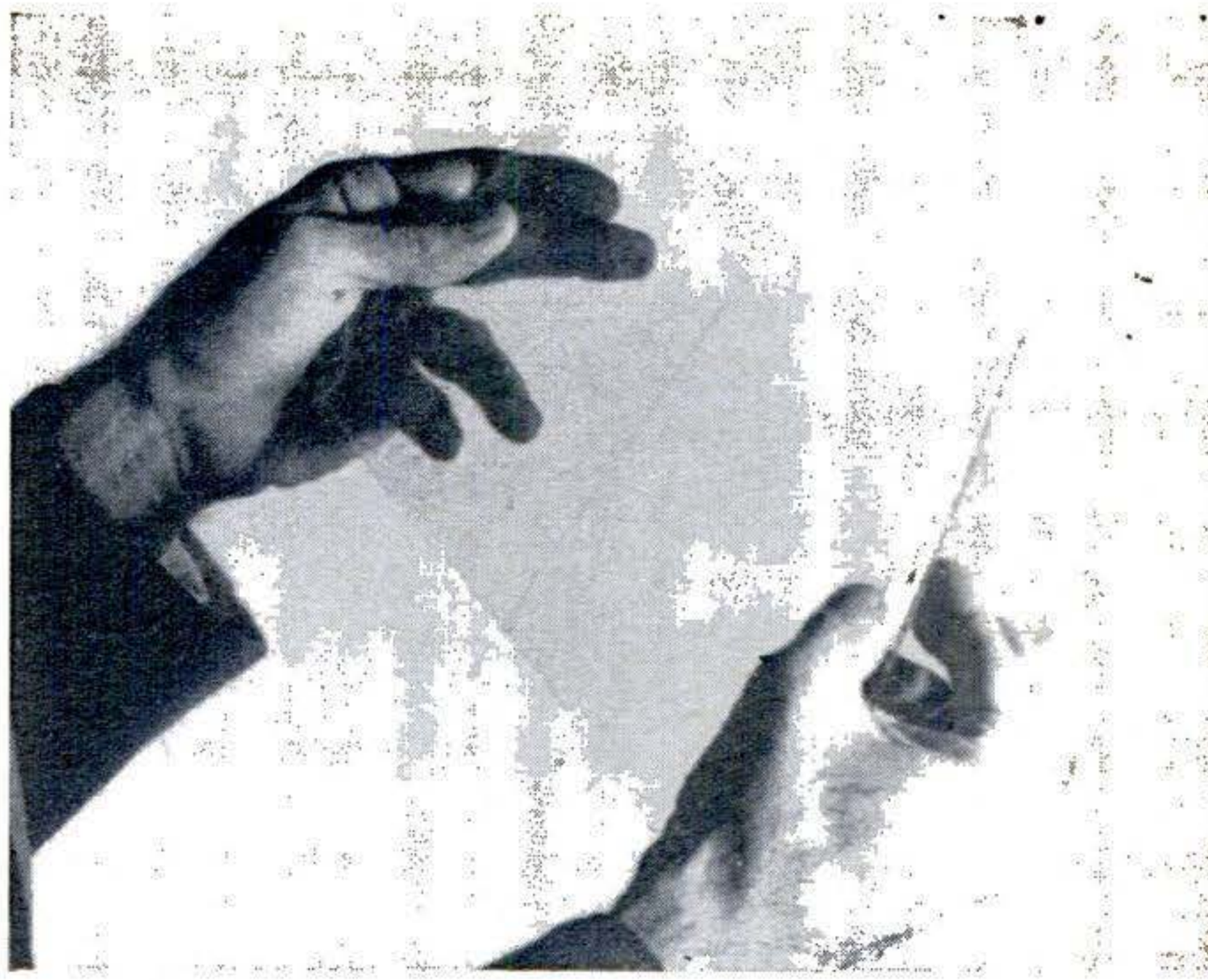
But it's in the medical realm that Hydron could perform its most dramatic roles. The hydrophylic plastic, remember, hits it off well with human tissue. At the Downstate Medical Center in Brooklyn, N. Y., and at the Brooklyn Jewish Hospital, surgeons have been trying out Hydron material for internal prostheses such as man-made tracheas, blood vessels, and the like. At a recent convention of the American College of Surgeons, Dr. Bernard S. Levowitz reported the effective use of Hydron-coated urethral catheters to combat infections.

In animal tests, sutures have been coated with Hydron to ward off virulent staph infections and to prevent bleeding. During surgery, soft plastic prosthetic devices can be impregnated with an antibiotic, hormones, anticoagulants, and other water-soluble medications that slowly leach into the patient's body. G. D. Searle and Co. is working with Hydron in the broad field of veterinary and human medicine. A team of American plastic surgeons, following the Czech lead, has begun to use Hydron for artificial breasts after cancer surgery.

Still other uses. In ophthalmology, one university is working on a Hydron sclera lens (covering the entire eyeball) which would allow constant, minute delivery of a drug to the eye. British doctors are experimenting with Hydron as a treatment for severe burns.

Meanwhile, back at Hydron's New Brunswick labs, the night lights are burning. Last October, the size of the plant was tripled. Czech chemists have been borrowed from Dr. Wichterle's institute. At least a dozen young American scientists, sensing the growth potentials in the soft plastic, have left Celanese Corp., American Cyanamid, Becton Dickenson, and other companies to join the Hydron team. But much development work is left.

Invented in a Czech laboratory, the intriguing, versatile substance known as Hydron may eventually make possible some unique new products as well as vastly improved versions of older ones. PS



A sheet of Hydron, fresh from a water bath, is flexed to demonstrate its unusual properties. Shown at the right is a tube made of the same material.

Constant refinements are coming from Hydron Labs and from a number of other companies that are exploring possible applications for the new material.

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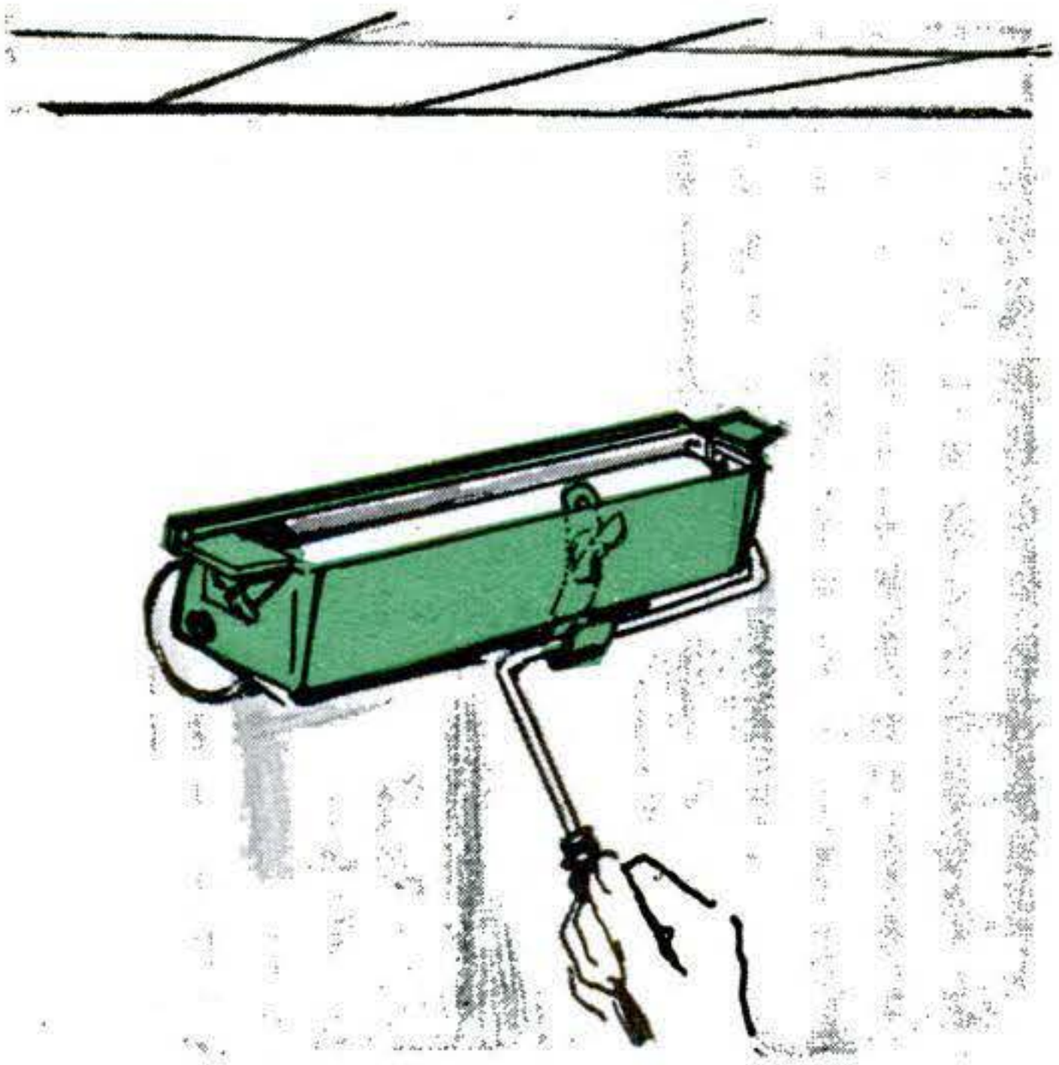
New Ideas from the Inventors

DRAWINGS BY WILLIAM CASTIMORE

Balloon buoys work scaffold. Repair and maintenance on hard-to-reach structures might be speeded by this recently patented assembly. Platforms would be carried to the job inside a large frame that also holds an inflatable bag. When gas was pumped in, the bag would support all or most of the scaffold's weight. Tether lines would be anchored or weighted at the ground, and winches would allow workmen to raise or lower the unit.



Roller pad trims edges. A square-cut sponge lip on this roller attachment would let you paint right up to the dividing line between two walls or a wall and ceiling. By setting the adjustable stops and angling the lip forward, you could get into corners that a roller could normally not reach. Wing nuts would let you adjust the stops and the handle angle to do the job neatly and efficiently.

Spring tips bed for cleaning. Counterbalanced springs under both sides of the divided base of this bed would make it easy to tip up the sides for under-the-bed cleaning. The raised sides would support themselves. Pushed down, the halves of a double or king-size bed would lock under a single mattress. Connected or separate twin beds could be counterweighted in a similar manner.

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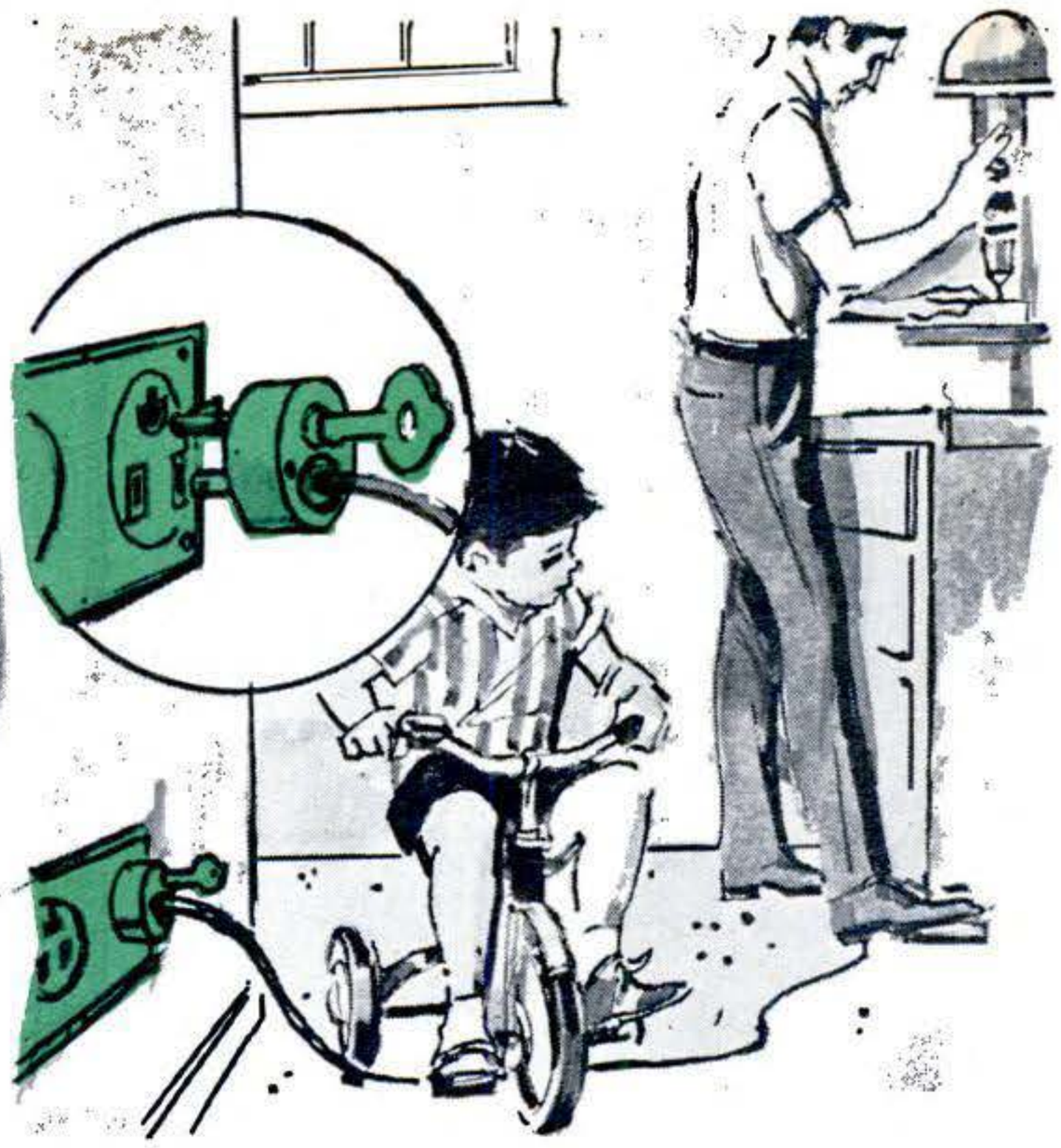
Sprinkler protects fire fighter. A rotating sprinkler on the crown of this helmet would protect a fireman who has to move through flames on a rescue mission. The spray would also help to fight the fire. Valves would divide the flow of water (or of chemicals carried in a backpack) between the helmet spray and a hand-held hose.



Prong locks electric plug. Plug-in electrical equipment couldn't be disconnected accidentally—or be pulled deliberately for mischief—if the plug had this locked-in prong. A projecting catch on the grounding pin of the three-wire plug would engage a stop in the socket. A key would be needed to turn or retract the catch to free the plug.

Canopy extends camper. Pleated let-down hoods at one or both ends of this trailer would increase floor area and living space when the trailer was parked. With the ends folded up, the compact trailer would be easier to tow and maneuver, especially on rough roads. The ends could be removed for easier access or for loading large items.

The following patents have been issued on these inventions: **Inflatable scaffold**—*No. 3,393,769 to V. W. Springer, Shreveport, La.;* **Trimmer pad**—*No. 3,346,899 to F. J. Murphy, Wethersfield, Conn.;* **Tip-up bed**—*No. 3,341,868 to S. Ingildsen, Santa Clara, Calif.;* **Helmet spray**—*No. 3,352,364 to C. J. De Coste, East Providence, R. I.;* **Locking plug**—*No. 3,345,603 to S. A. Cohen, Baltimore;* **Trailer canopy**—*No. 3,351,373 to G. E. Christin, Marnes-la-Coquette, France.*

Copies of patents may be ordered, by number, from the Commissioner of Patents, Washington, D. C. 20231, at 50 cents each. To write to an inventor, if the address above is insufficient, address him (by name and patent number) in care of the Commissioner of Patents.

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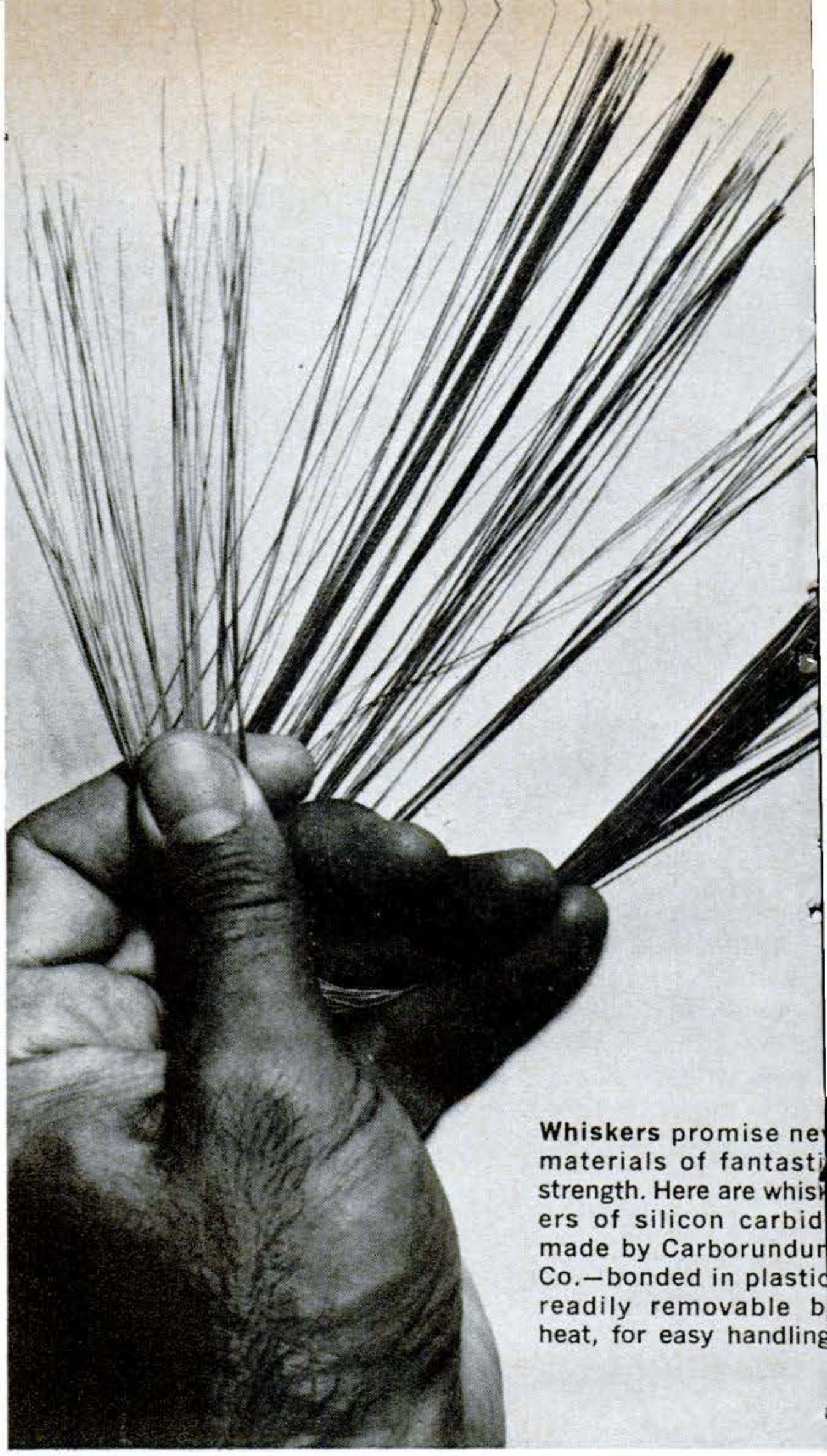
Lighter Than Aluminum ...Stronger Than Steel!

Exotic new composite materials of the Space Age—built around filaments of boron and graphite, and crystal "whiskers"—promise a magic carpet for aerospace designers



Whiskers promise ne materials of fantasti strength. Here are whis ers of silicon carbid made by Carborundur Co.—bonded in plastic readily removable b heat, for easy handling

By DR. WERNHER VON BRAUN

Director of NASA's George C. Marshall Space Flight Center, Huntsville, Ala.

Ever since Explorer I, our first satellite, the Space Age has stimulated a search for materials that are stronger, stiffer, lighter, and usable at higher temperatures than any before. From this quest is now evolving a family of extraordinary structural compositions—lighter than aluminum and stronger than steel.

Collectively they are called "fiber-reinforced composite materials." In other words, to make them, high-strength fibers of one substance are embedded in a matrix of a different substance.

This idea has been demonstrated before by the success story of fiberglass—whose strong but brittle glass fibers impart their strength to a protective matrix of epoxy resin. Into the new composite materials, however, go far more exotic substances than glass:

Strength-adding ingredients include filaments of boron or graphite, and "whiskers"—needle-shaped

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single crystals—of metals or ceramics. Either a resin or a metal can serve as the matrix.

What can we do with them? Breathtaking possibilities await the full development of these advanced materials:

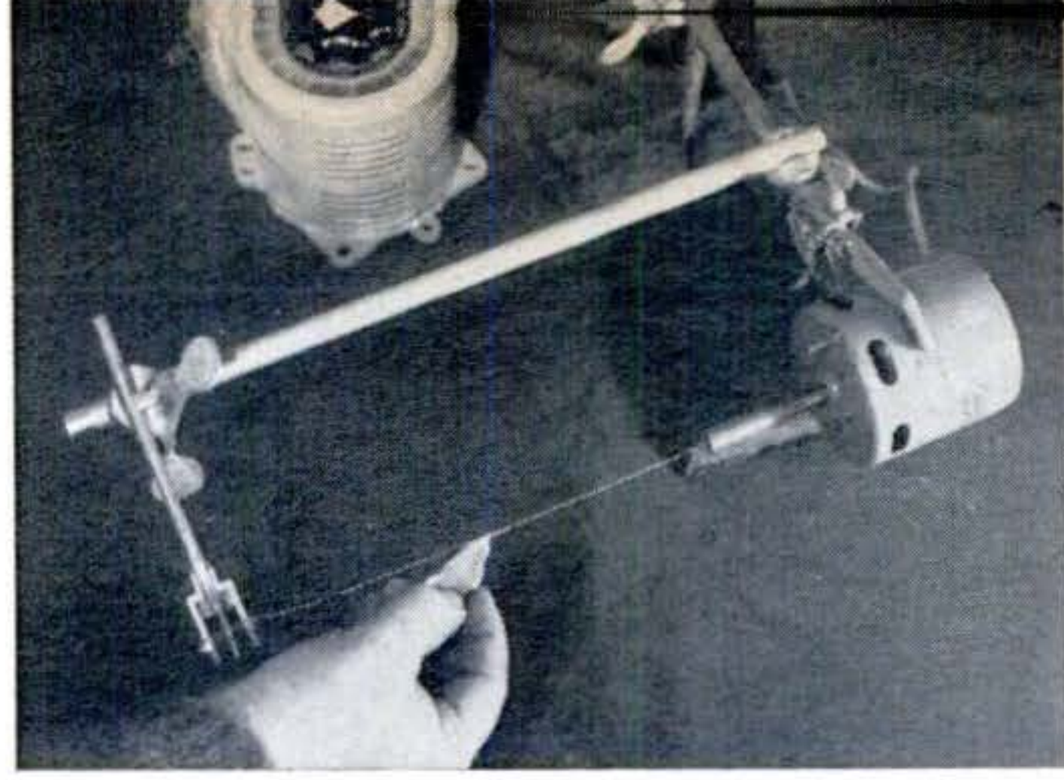
They could make possible a skyscraper a mile high—or a suspension bridge twice as long as is feasible today.

In military and commercial aircraft, predictable results of their use appear revolutionary. By making wings and fuselage of the new materials (instead of aluminum and other metals), the structural weight of an airplane may ultimately be reduced by as much as a third. Just a 15-percent reduction, Northrop engineers conservatively calculate, would enable a high-performance military jet to fly 10 percent farther or carry 30 percent more ordnance on the same amount of fuel. Its takeoff would be 15 percent shorter; its rate of climb, 10 percent faster.

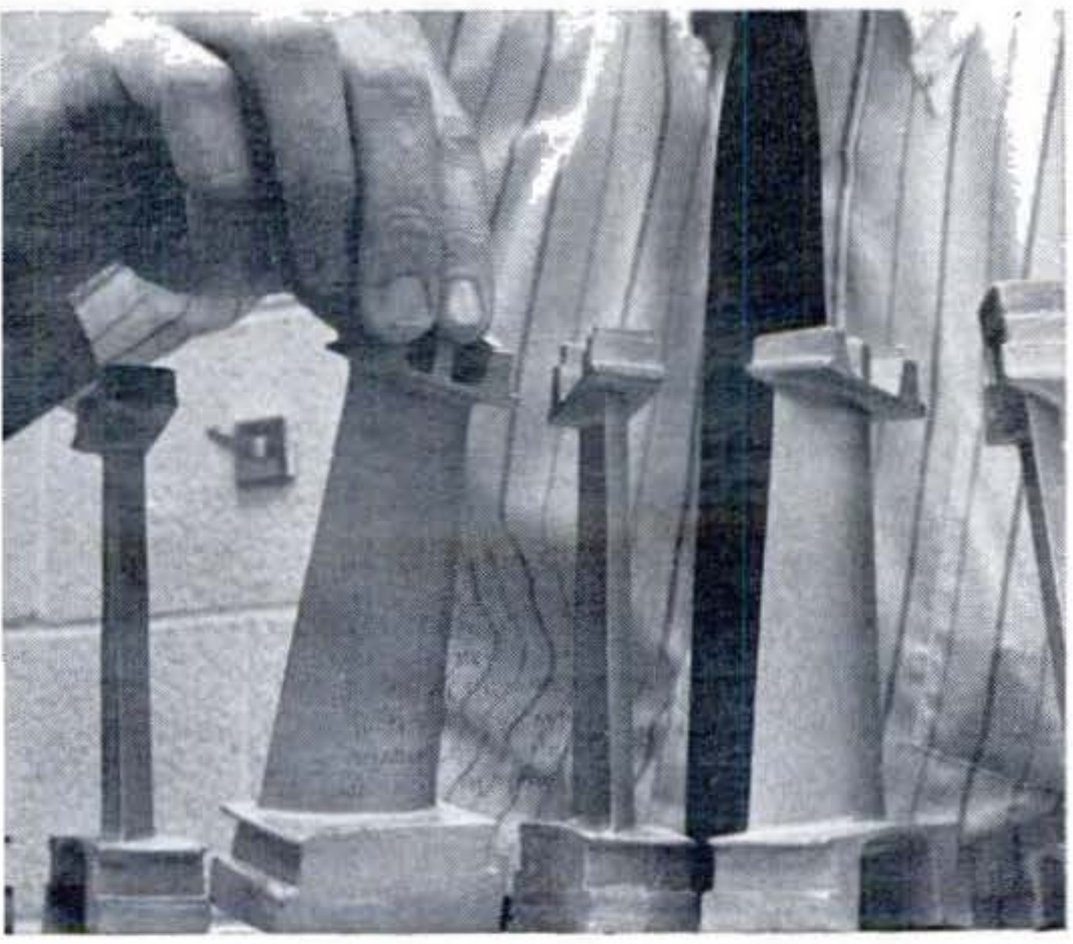
Other likely uses are in space vehicles, deep-diving structures, solid-propellant rocket cases, jet turbine blades, and nuclear power plants.

The first hardware. Boron and graphite composites are the first of the exotic materials to reach the form of actual hardware for trial.

For aircraft, a boron-and-epoxy-resin composite has been made into a rudder, a landing-gear door, a flap, and horizontal stabilizers. Due next, on the way to whole airframes, are a landing-gear strut, helicopter-rotor blades, and a "wing box," the major load-bearing segment of an advanced swing wing.



Mechanical whisker-spinner, developed in study for NASA by General Technologies Corp., turns whiskers (from hand-held wad) into yarn. Combining yarn with matrix of metal or resin gives superstrong material.



Jet-engine turbine blades with grown-in whiskers are made by United Aircraft Corp. process called "unidirectional solidification." These heat-resisting cobalt-base blades are latest product of method.

Pure boron, a chemical element lighter than aluminum, is a brownish crystalline substance. Depositing it from its vapor on hot and thin tungsten wires yields the boron filaments in the resin-composite hardware. By drawing close-packed boron filaments through a molten-magnesium bath, a NASA contractor has also produced boron-magnesium rods, which are called "immediately" capable of providing structural members for space vehicles.

A promising and less-expensive rival of boron has lately appeared in the form of high-strength, lightweight filaments of graphite, obtained by heat treatment of rayon or other fibers. Test hardware of graphite-and-resin composites now is getting flight trials, too.

So novel are these structural materials that many steps in producing them resemble textile-making more than metallurgy. Another departure is that the reinforcing fibers can be oriented to give greatest strength in one direction, for a structural member stressed mainly in that direction. These observations apply equally to whisker materials.

Whiskers—best of all. For a decade it has been known that whiskers will make the best reinforcing fibers of all, especially for use at high temperature.

The story of whiskers began when mysterious short circuits in electrical equipment were traced to tiny metallic strands that sprouted spontaneously from metal terminals. Discovery of the amazing

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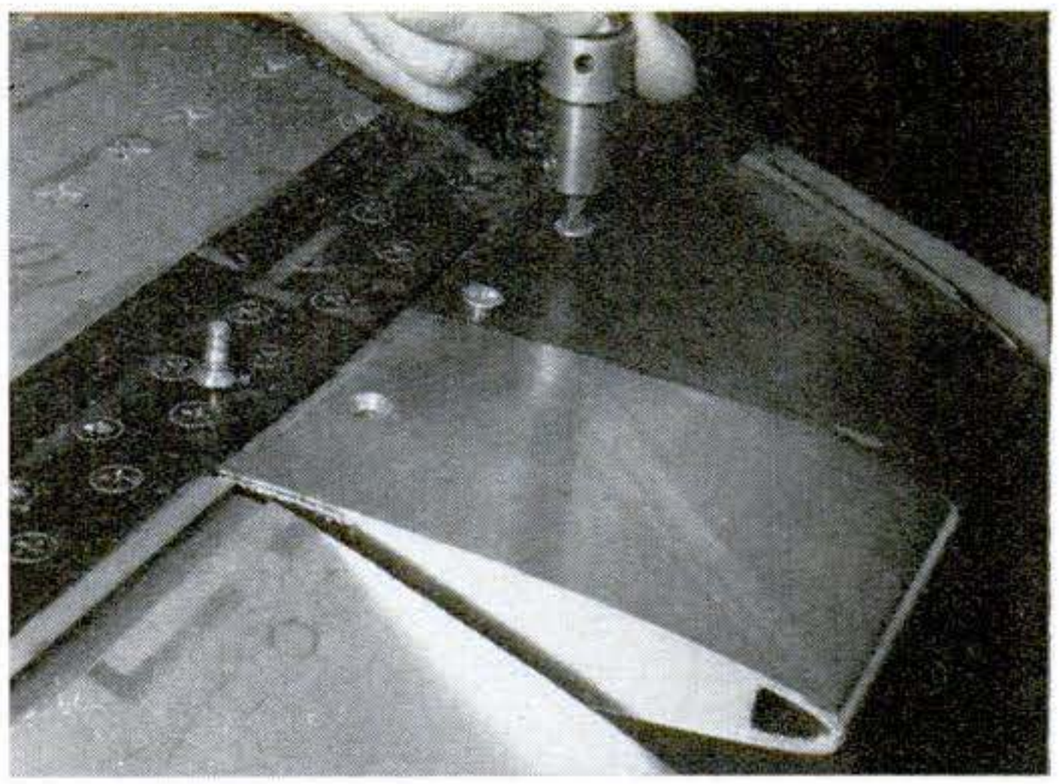
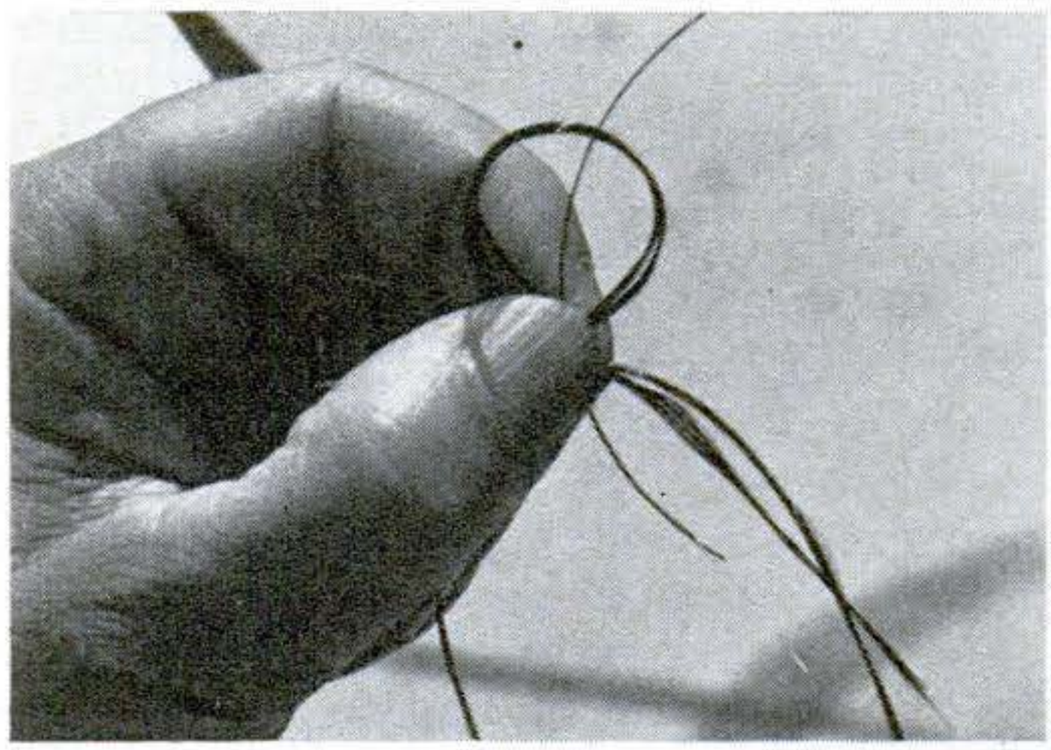
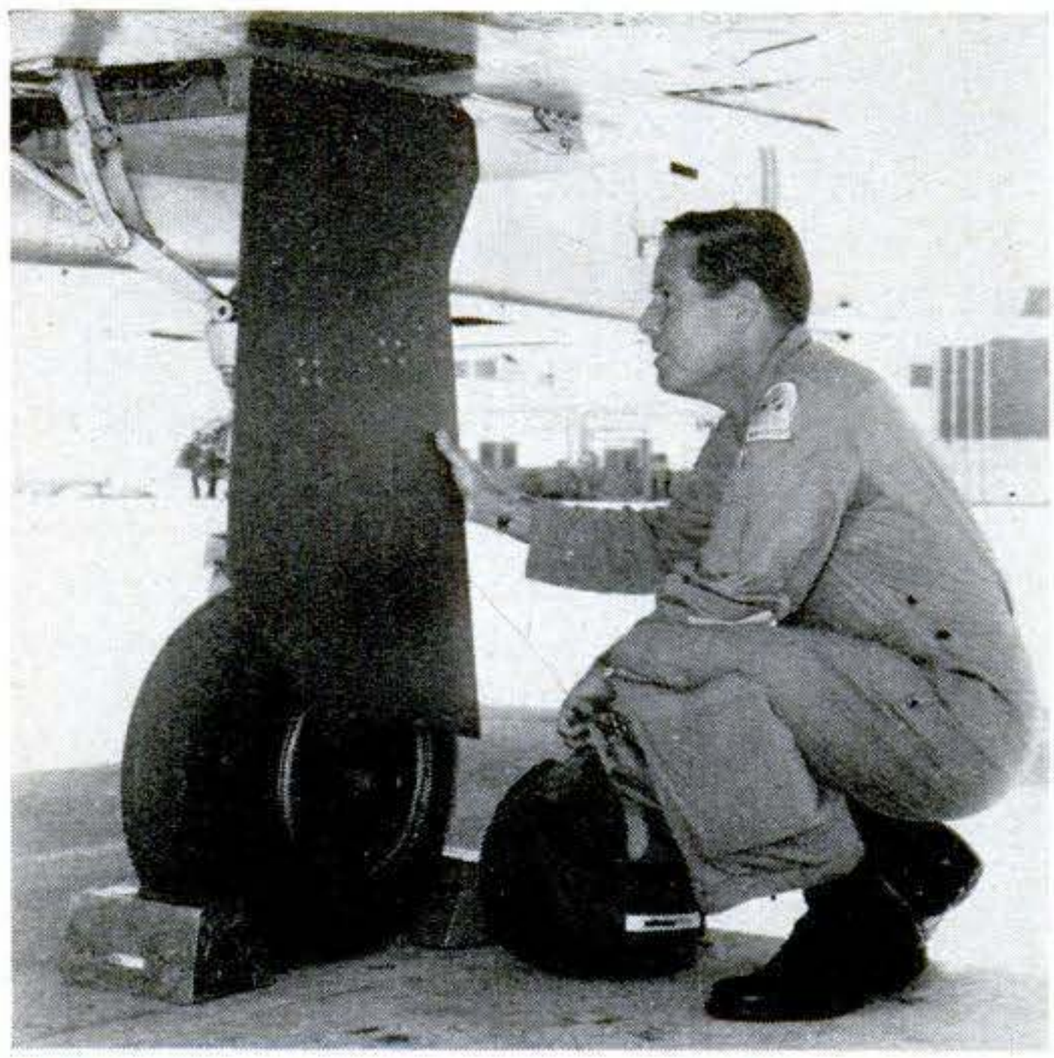


Leading-edge section of graphite composite, twice as strong as steel but 40 percent lighter than aluminum part it replaces, goes on F-5 fighter wing for successful trial. Shiny half of it is nickel-coated.



These graphite filaments, made by intense-heat process from rayon threads, are combined with epoxy resin, wound on mandrel, and cured by heat and pressure to form graphite-composite parts.



Landing-gear door of boron composite, 29 percent lighter than usual aluminum door, meets test on F-5. Skin is of bonded layers of epoxy-resin type containing hair-thin tungsten wires coated with boron.

strength of these whiskers, and also of nonmetallic ones, followed.

The strength of whiskers such as those of sapphire (alumina) approaches the magnitude of interatomic forces—which, in theory, set the limit of stress a material can take without being pulled apart. In practice, familiar structural metals come nowhere near this theoretical strength, because of imperfections in their crystal structure. But the tiny diameter of whiskers, on the order of 1/25,000 of an inch, minimizes the likelihood of imperfections in them.

For researchers on whisker materials, silver serves well as a "model" matrix. In trials at room temperature, silver containing 10 to 15 percent of sapphire whiskers by volume ruptured at 63,000 pounds per square inch (p.s.i.), compared to 17,000 p.s.i. for pure silver. At 1,400 degrees F. it still withstood 44,600 p.s.i.; the silver, a mere 2,000. Even at 1,720 degrees, just 40 short of silver's melting point, the whisker material retained a tensile strength of 25,000 p.s.i.

Such phenomenal gains in strength are by no means limited to sapphire whiskers. Among promising ones are whiskers of boron carbide, beryllium oxide, silicon dioxide, and silicon carbide (an abrasive trade-named Carborundum).

There is also a wide choice of matrix materials. Particularly significant for the weight-conscious designer of aerospace vehicles is the resulting strength-to-density ratio—which is successively higher for sapphire whiskers in silver or nickel, in aluminum, and in epoxy. We see that whisker-reinforced epoxy resin looks awfully attractive, at least at moderate temperatures.

What are we waiting for? Why don't we start using whiskers on a big scale? The answer is that they offer a classical example of a promising idea that takes years of applied research to put into industrial practice.

While whiskers still are costly ($750 to $10,000 a pound), making them is not too difficult. They can be grown in furnaces by condensing their vapor on a graphite base, and in other ways. As desired, they can be coarse or fine, curly or straight. They range from a few hundredths of an inch up to inches long; a handful of them

[Continued on page 202]

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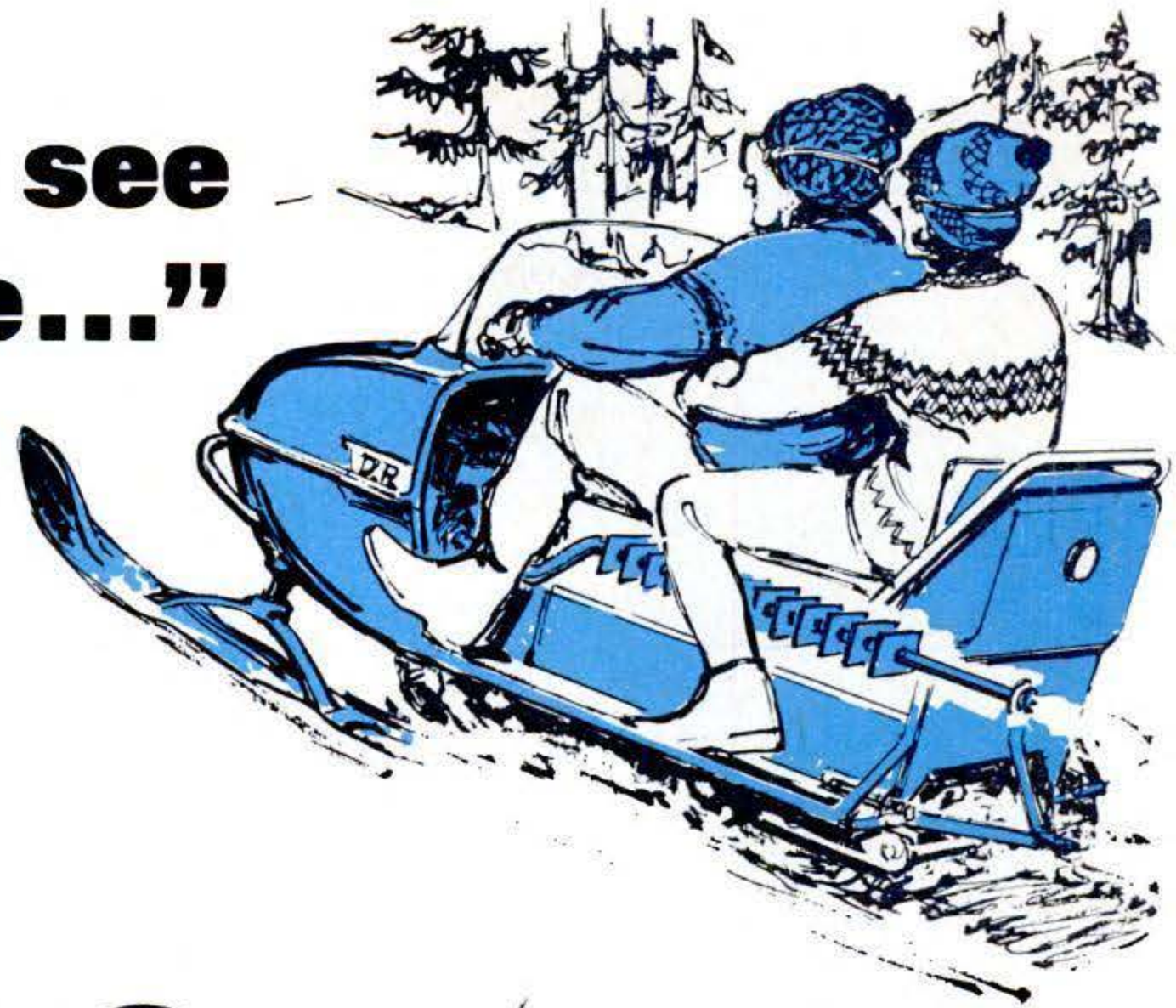
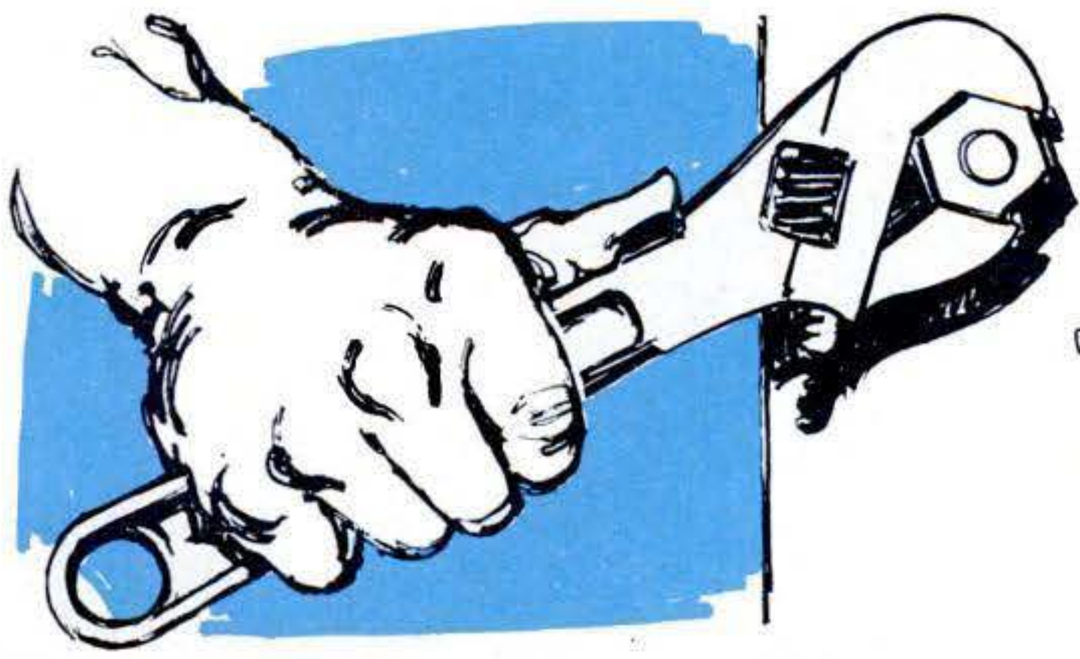
"I'd like to see them make..."

DRAWINGS BY DANA RASMUSSEN

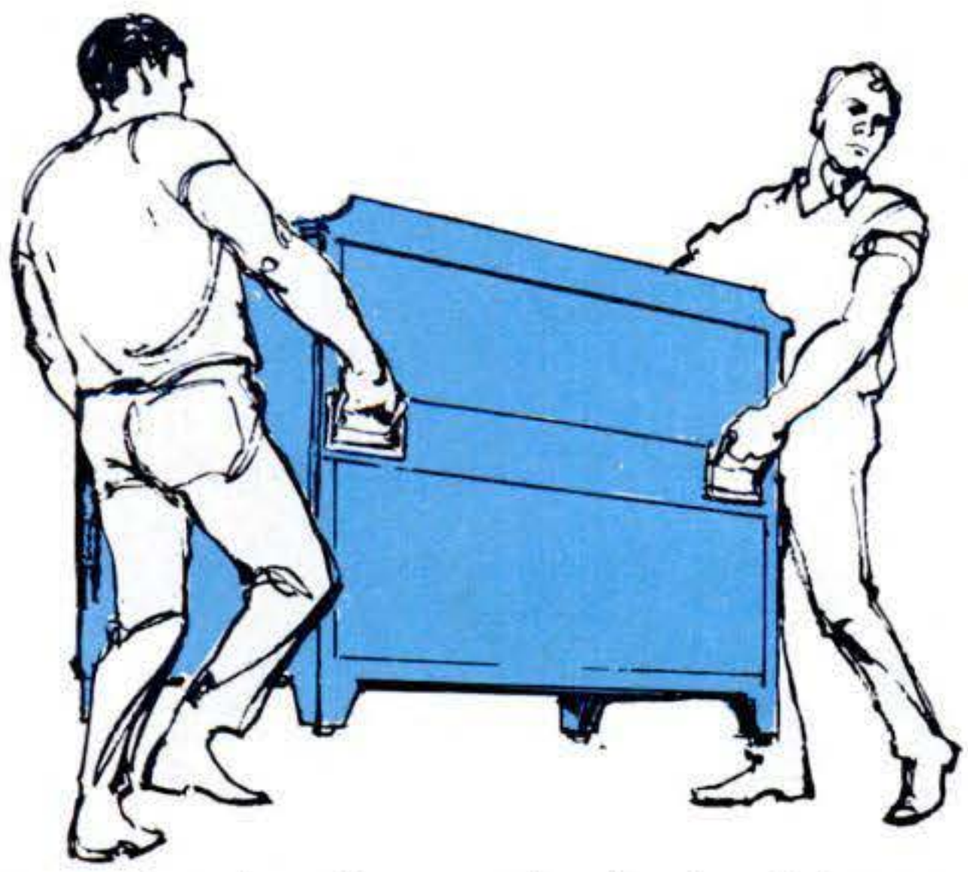


Built-in heaters under the seats of snowmobiles. Why freeze, while engine heat is wasted instead of being sent where it could do the riders some good?—*Don Picetti, Millbrae, Calif.*

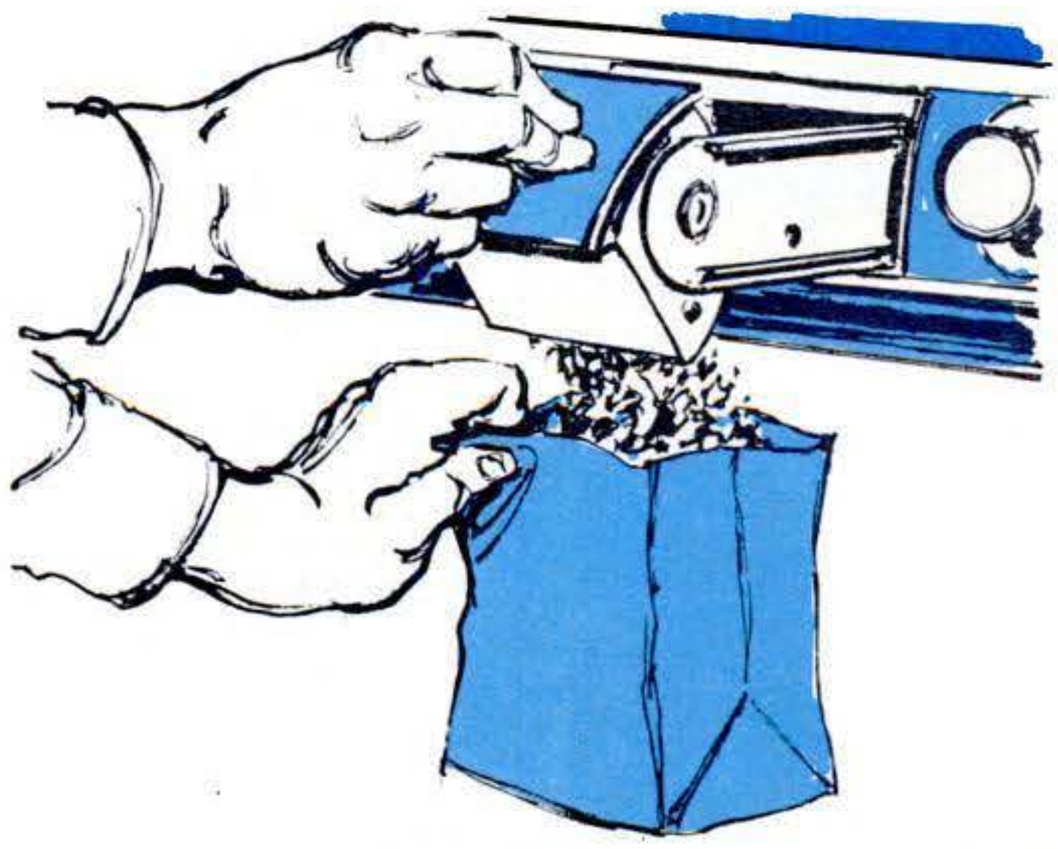


Crescent wrenches that are self-adjusting. Slight thumb pressure on a spring-loaded button would set the movable jaw against a nut.—*Dave Orewiler, Mansfield, Ohio.*

Spray-on, peel-off plastic to protect your hands from chemicals. Rubber gloves tear easily when surfaces are rough or you're gripping steel wool.—*E. Rouse, Buffalo.*



Disappearing handles at the back of heavy pieces of furniture. They'd make it easier and safer to move or lift a long buffet or a double bureau.—*A. Vena, Philadelphia.*



Easier-to-empty ashtrays in cars. Instead of removing the tray, you'd just pull it out and tilt it to let contents drop into a litter bag. —*Jeannie Heitz, Lakeview, Ore.*

Everyone has his own pet idea of a gadget that he would like to see in general use. What's yours? We will pay $5 for each one published. Please use Government postcards only. Send to ILTS Editor, Popular Science, 355 Lexington Ave., NYC 10017. Write your name and address clearly. Contributions cannot be acknowledged or returned.

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FOR THE BIG FAMILY. *OMC-powered Glastron V-214 Vagabond converts to camper. Has concealed let-down steps in transom for boarding; lift-out bait or ice well. A big boat: 21'4" long, 92" beam. Takes power to 210 hp.*

PS BOATING

Pick the Best Boat for Your Wants and Your Waters

What boat? What power? Here are specific suggestions, for specific types of use. Deciding is part of the fun

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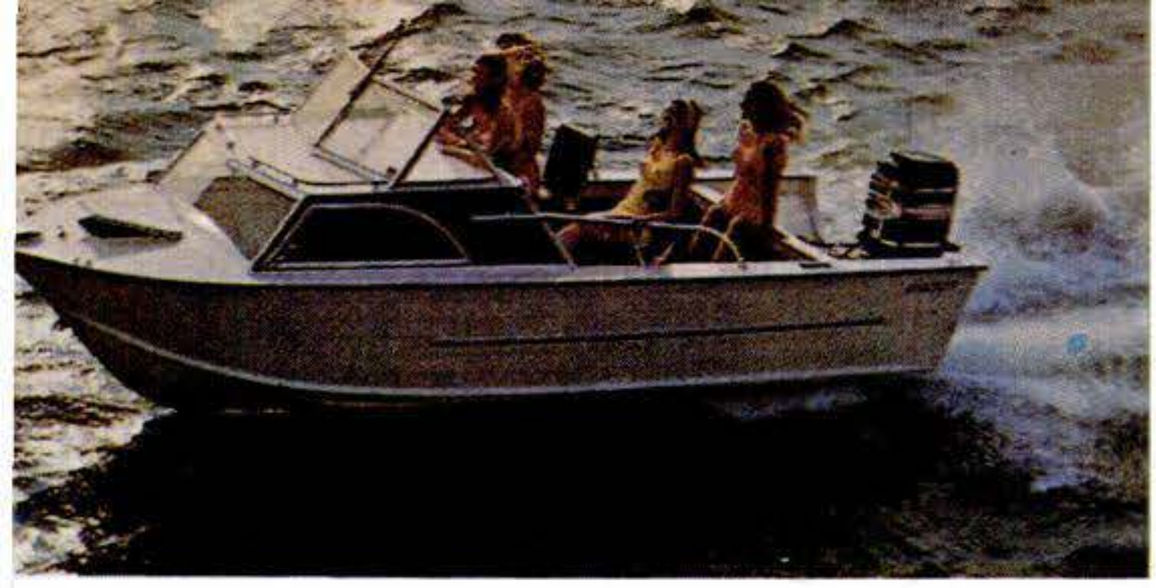

FUN — RAIN OR SHINE. *Compact cabin cruiser, Starcraft Starchief-V, comes as outboard or stern drive. Hull is aluminum. She's 18'2" long, carries convertabeds.*

FAMILY OVERNIGHTER. *One of the hottest boats, Chris-Craft's 26' Futura at $5,990 was so popular last year, there's now a 28' Futura, a six-sleeper, for about $9,000.*

FAMILY-SIZE CRUISER. *Chrysler's 24' aluminum Cruise Liner III has 96" beam, handles up to 230 hp., carries 3,200-lb. load. Has galley, head; sleeps a family.*

ROOMY RUNABOUT. *18' Holiday-V by Starcraft has walk-through windshield, sleeper/lounge seating. Stern drive or outboard. Aluminum — easy to trail, launch.*

Continued

By JIM ROE / *PS Boating Editor*

Boats are better than ever, and the models and power options more numerous than ever, too. How do you pick one to skipper? Well, picking a boat is an affair of the heart as well as of the mind. You'll make your final choice when that one particular boat starts sending your heart into a quicker beat.

But just then, in the early stages of selection, you'll do well to apply some cold-blooded logic. Do you want a family boat, a sports speedster, a fisherman, a day sailor? Will your boating be done on protected or exposed waters?

On these eight pages you'll find a broad selection of the 1969 boats to aid you in making your decision. And whatever your choice—among these and all the new craft waiting to hit the water—PS wishes you a great season of boating pleasure.

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FAMILY BOATS

BOW-RIDER. *Glasspar has attractive family of tri-hulls, 14 to 18′, all of Life/Guard construction. Power: Mercury.*

UTILITY RUNABOUT. *Evinrude-powered Starcraft offers low-cost family recreation. Performs well with 40-hp. motor. Lightweight: easy to trail, launch, recover.*

TRI-HULL ALL-PURPOSE. *This 16-footer, in fiberglass, has many handy features: bow-riding area, walk-through windshield, soft tri-hull ride. It's Starcraft's Trident-TR.*

TAKE-'EM-ALL BOAT. *The Johnson Surfer is 21′ long, with 210 stern-drive horses. Fiberglass, tri-hull. A stable boat, with lots of room for any boating activity.*

FOR THE YOUNG AT HEART. *Chrysler's Sport Fury, with Chrysler 85-hp. outboard, has cathedral hull, is 16' long. Stern drive or outboard. Can take power up to 130 hp.*

FRONT PORCH TO GO. *Glastron's Fun-deck is 18' of fishing platform, scuba base, party floor. Fly-bridge-type control console has seat for two. Power is from a Mercury outboard.*

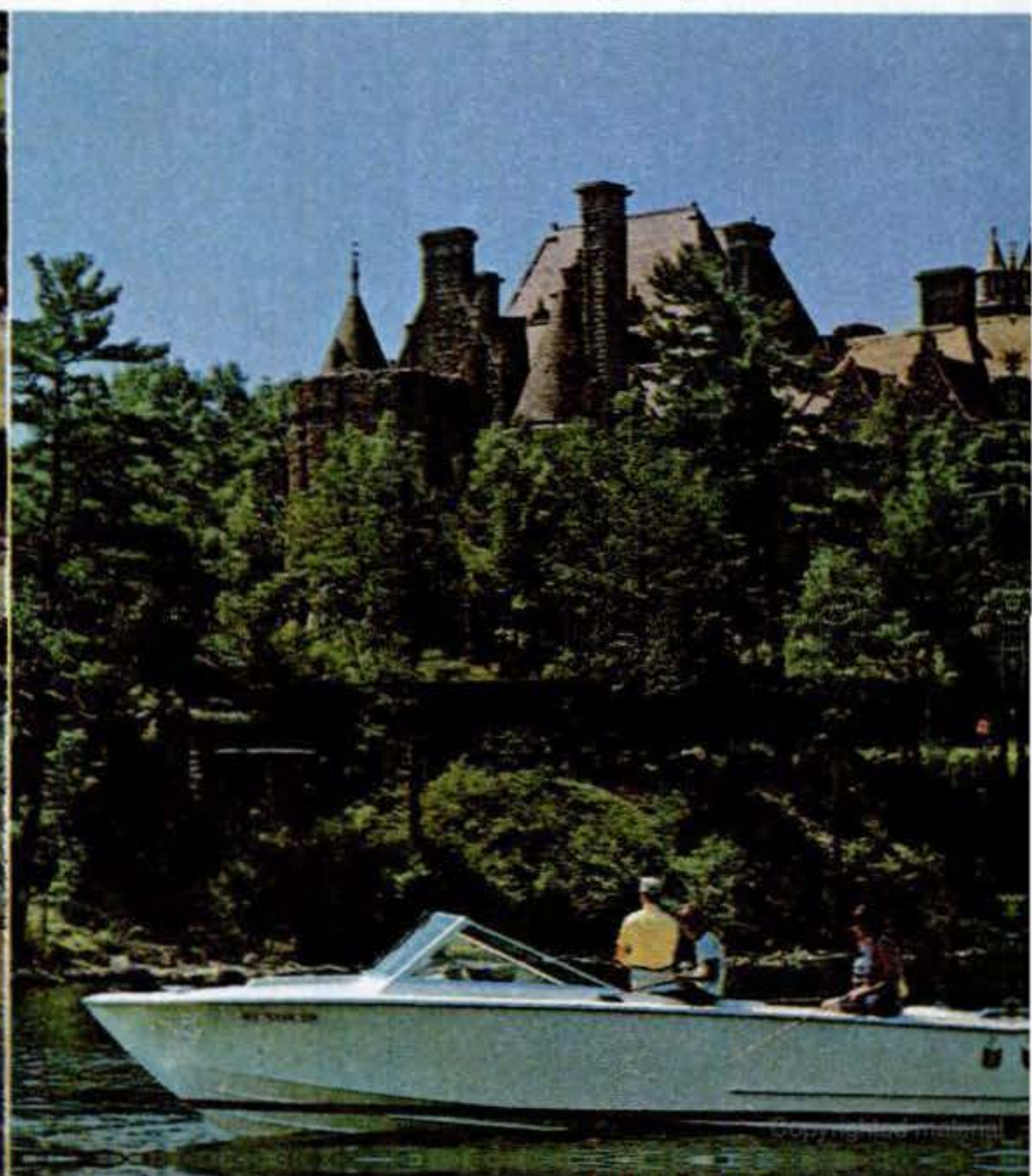
CATHEDRAL HULL. *Big Thunderbird, 19' Comanche has double berths, marine head, 36-gal. fuel capacity. $2,595 as outboard, $4,785 with 120-hp. MerCruiser stern drive.* Continued

FISHERMAN'S DELIGHT

FOR THE LADIES. *Want the gals to enjoy fishing, too? Take them along with you on*

BACK-COUNTRY FAVORITE. *Light, tough, and Johnson-powered, this Lund C-14 carries 10-year guarantee. This craft is a great favorite of fishing enthusiasts.*

ROOMY COCKPIT. *Corsair Lancer is 23' long, has large cockpit for fishing, ski handling, or carrying crowds. Competent, seaworthy, good-handling all-purpose boat.*



this day-cruiser by Starcraft.

BIG-WATER TROLLER. *Sportscraft Imperial has room out back for handling lines, room forward for a nap or for overnighting aboard. OMC stern drive powers it.*

FAITHFUL FRIEND. *It's hard to beat the tried-and-true lines of the classic fishing boat. This one, by Feathercraft is Johnson-powered. No frills — an honest boat.*

LILY-PAD SPECIAL. *Penn Yan 16′ Playmate, with tilt-up OMC stern drive gets you in where the fish are. Hull is stable for walk-around fishing. Great ski boat, too.*

TRAIL-IT-IN. *Aero-Craft is light, easy to transport into camping country. Medium-hp. Evinrude takes you to the fish. Fisherman on gunwale shows stability.* Continued

SPEED AND SPRAY

PERSONAL "UNLIMITED." *A 115-hp. Johnson out back powers this Hustler hull. Favored by the racing set, this combination gives the hustle for which it is named.*

JUST FOR FUN

LIGHTWEIGHT CARTOPPER. *Inflatable Lidair is a handily handled fun boat. Johnson 1½-hp. is all the power it needs. Motor is protected by hull.*

PERSONAL PICNICKER. *Avon Redseal, small Chrysler outboard, take you to secluded spots. On return, deflate it, tuck in car trunk.*

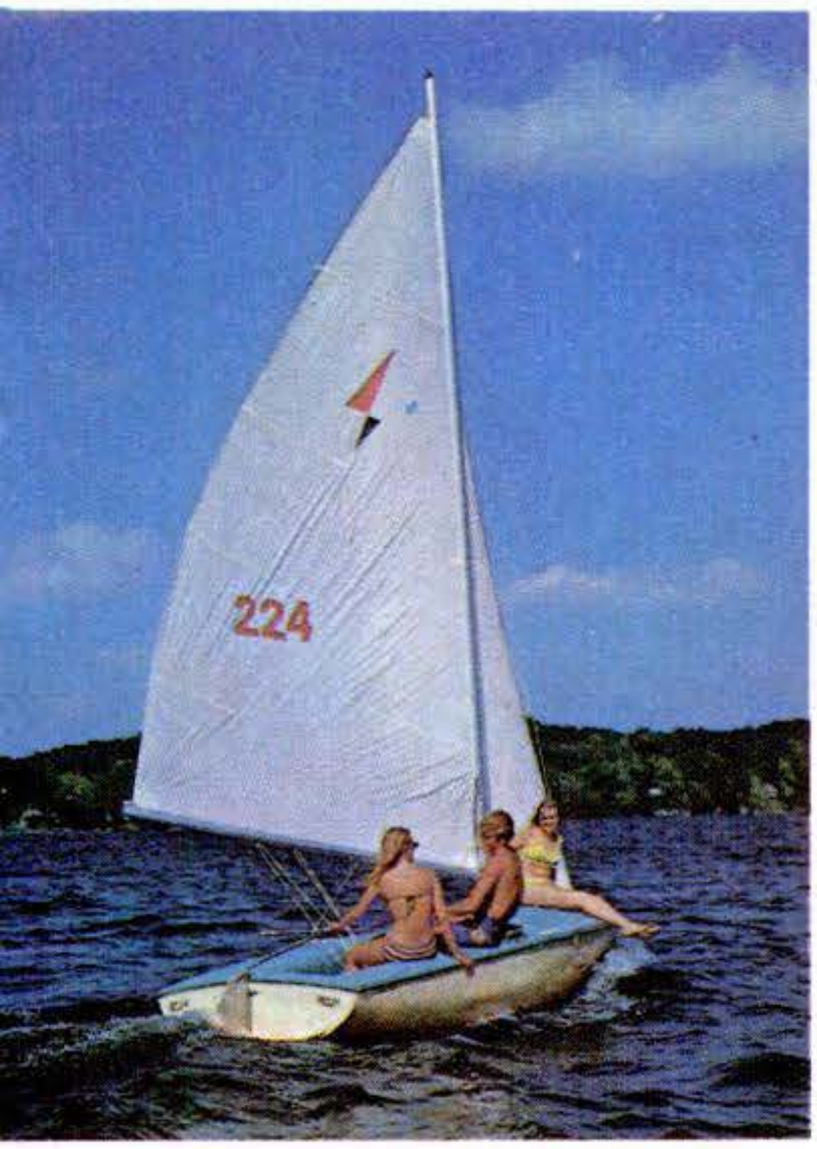
PEEK-A-BOO BOTTOM. *Glasshopper has a see-through hull. Great for diving in clear waters, fish-watching. Johnson outboard.*

SPORTS CAR WITH "TRAILER." *This is a wraparound boat. Evinrude outboard-powered, the G-W Invader is a quick-planing speedster that also handles a skier easily.*

CIRCULAR LOUNGE AFLOAT. *Mercury-powered Donzi is a sportster with lots of style, lots of high-performance history. A lively way to move fast on the water.*

SPEEDY STILETTO. *Sea Bird V-25 Stiletto, with OMC stern-drive power, is a high-performance sport boat. Passenger's chair rotates—handy for observing skier.*

RUMBLE SEAT. *Another of the speed hulls, this Cobra is MerCruiser-powered. Sport boats like this are increasingly popular with boatmen who like high horsepower.*



BUILT FOR TWO. *Fiberglass MFG sailor can also carry one or two more. Cockpit is self-bailing, rudder is kick-up for damage protection.*

FLOATING MOTOR SCOOTER. *Manatee, Mercury-powered, is light-hearted "boating." Highly maneuverable, surprisingly stable; you have to try it to believe it.*

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How to Survive in ROUGH WATER

When the wind goes into a howling tantrum and green water cascades over the bow, a skipper needs lots of knowhow to bring his craft home safely

By CHARLES R. MEYER

Rough water is a relative term. A "howling gale" to a fair-weather seaman may be a "puff of wind" to the skipper of an ocean racer. But to any boatman there can come a day of confrontation: with a rampaging lake whipped by a line squall, a stretch of rapids, or the problem of feeling his way through an unfamiliar inlet channel.

It's not a pleasant experience. But studying the basic precepts of practical "rough-water" boating should bring your rig through with minimum damage.

First considerations. Your hull behaves according to its length, the load, the nature of the waters. By using USGS charts before cruising, you can prophesy sea conditions. Equate the breeze. Check water depth and current strength.

And never overload a boat. Think of load in categories—solids, liquids, and people. Says Cmdr. R. I. Price of the U. S. Coast Guard: "Solids are the preferred load. They tend to be placed low in the boat, and small boats can carry a large amount of dead weight safely.

"Liquids appear as water in the bottom of the boat. Loose or free-surface water is a free-roaming thief. It not only steals from available freeboard as a weight ad-

Continued

As the sea swirls under the bow of this motor lifeboat, the force of the comber acts against the hull to throw the boat sideways and broadside to a subsequent wave. Once the cockpit loads up and the wheel is sluggish, you're in danger of broaching.

Navigating past fresh-water rapids can be trickier than riding an inlet. This double-ender is being rowed along the McKenzie River in the vicinity of Eugene, Ore. The skipper permits the current to carry the hull, guiding its course by oar power.

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Climbing a rugged breaker near Newport Harbor, Ore., this 44-foot Coast Guard lifeboat exemplifies the USCG philosophy on rough-water boating (as expressed by one chief petty officer): "You have to go out—but they give you a little leeway about coming back." Boat is specially designed for rough seas.

With a chop striking at approximately 45 degrees to his bow, Jerry Dominy of Bellport, N.Y., holds a 24-foot Kenner Viking steady despite the waves, while Dave McCutcheon lands an unwary striped bass. It takes a top-notch skipper to fish in Plum Gut.

Jumping a nasty wind swell off Mattituck Inlet, Long Island's Chester Arthur advances twin Evinrude throttles on his Formula 23-foot hull. Timing is most important—increasing the speed just a few seconds too soon would have made her pound.

On a routine winter patrol out of the U.S. Coast Guard Rescue Station at Yaquina Bay, Ore., this 52-foot patrol craft charges through a giant breaker that would have obliterated a lesser hull.

dition, but also from the wedge of buoyancy which restores equilibrium. Then there are people—a different cargo, high in the boat, but similar in behavior to free-surface water. People stand up, walk aft, walk forward, climb up, sit on the gunwale. When the weather acts up—they slip, slide, fall, lurch, and lean over the rail. You could make a strong case for seat belts."

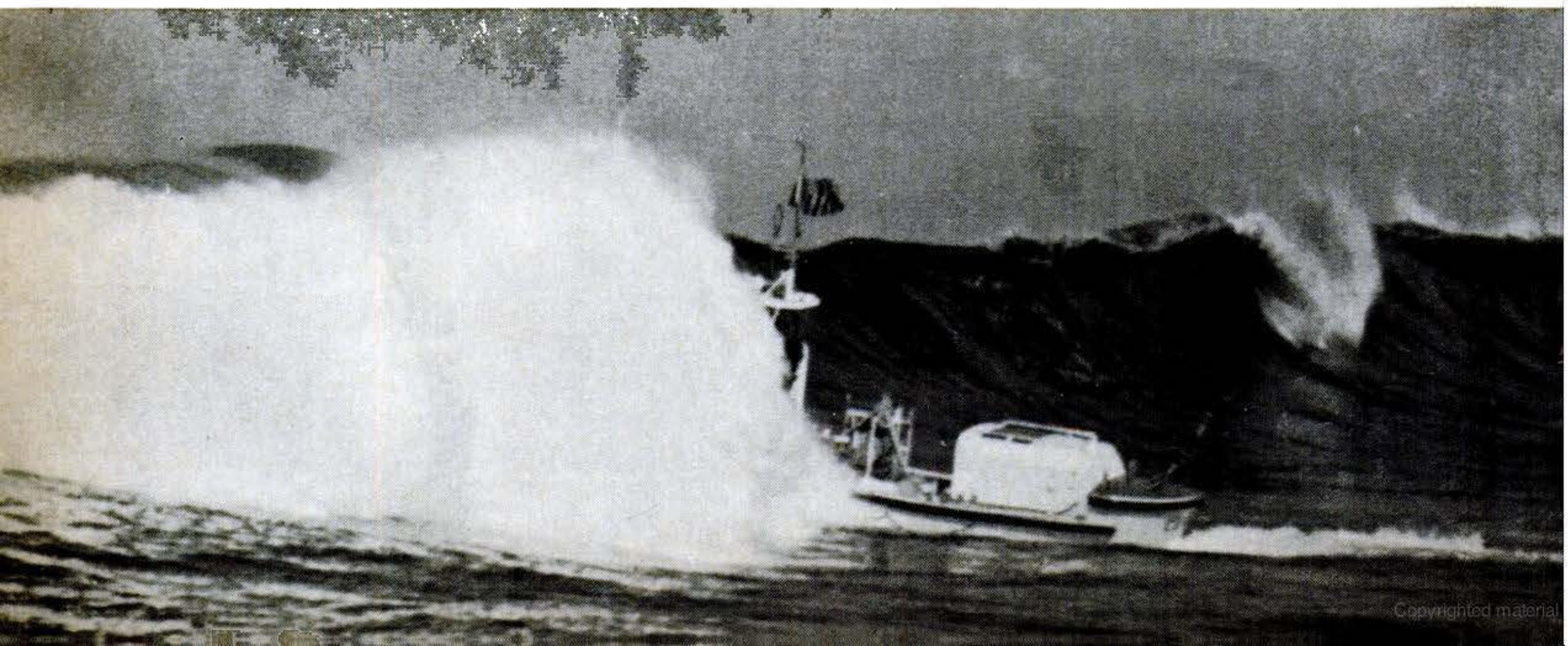
What should you do? Heed weather forecasts, never overload, and, if caught in rough water, follow these simple rules:

- Stow cargo low and secure it for sea.
- Distribute passengers evenly and keep them seated.
- Don't lie broadside to a sea or another vessel's wake.

But suppose you've taken due precautions and still get stuck in an uncomfortable situation. You must reduce speed to avoid shipping water—you can swamp a boat by driving forward too fast, particularly with poor trim.

Meeting the waves bow-on. You're lucky if you can see whitecaps over the bow. This is the least of troublesome rough-

Conventional smallcraft hulls can't survive green water descending on the bow in quantity. You must rise to a sea, instead of attempting to charge through. Even with self-bailing scuppers and watertight deck, you're tempting fate trying to duplicate this Coast Guard maneuver. Because it is self-righting and built for the purpose, this 44-footer runs the surf.



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Spray flies over the windshield of this twin-engine outboard as it faces a head-sea. The boat is built to withstand this type of punishment, but danger arises when the helmsman is blinded by flying spume.

water conditions. A boat with too much weight forward will plunge into the waves; too much weight aft will cause it to fall off. Assuming your boat is properly loaded, slow the throttle so the bow has the time to rise.

How much speed? Judge by the pounding sensation. Cut back so the "slap" is minimized. Be sensitive about green water landing on the deck forward and sloshing down into the cockpit.

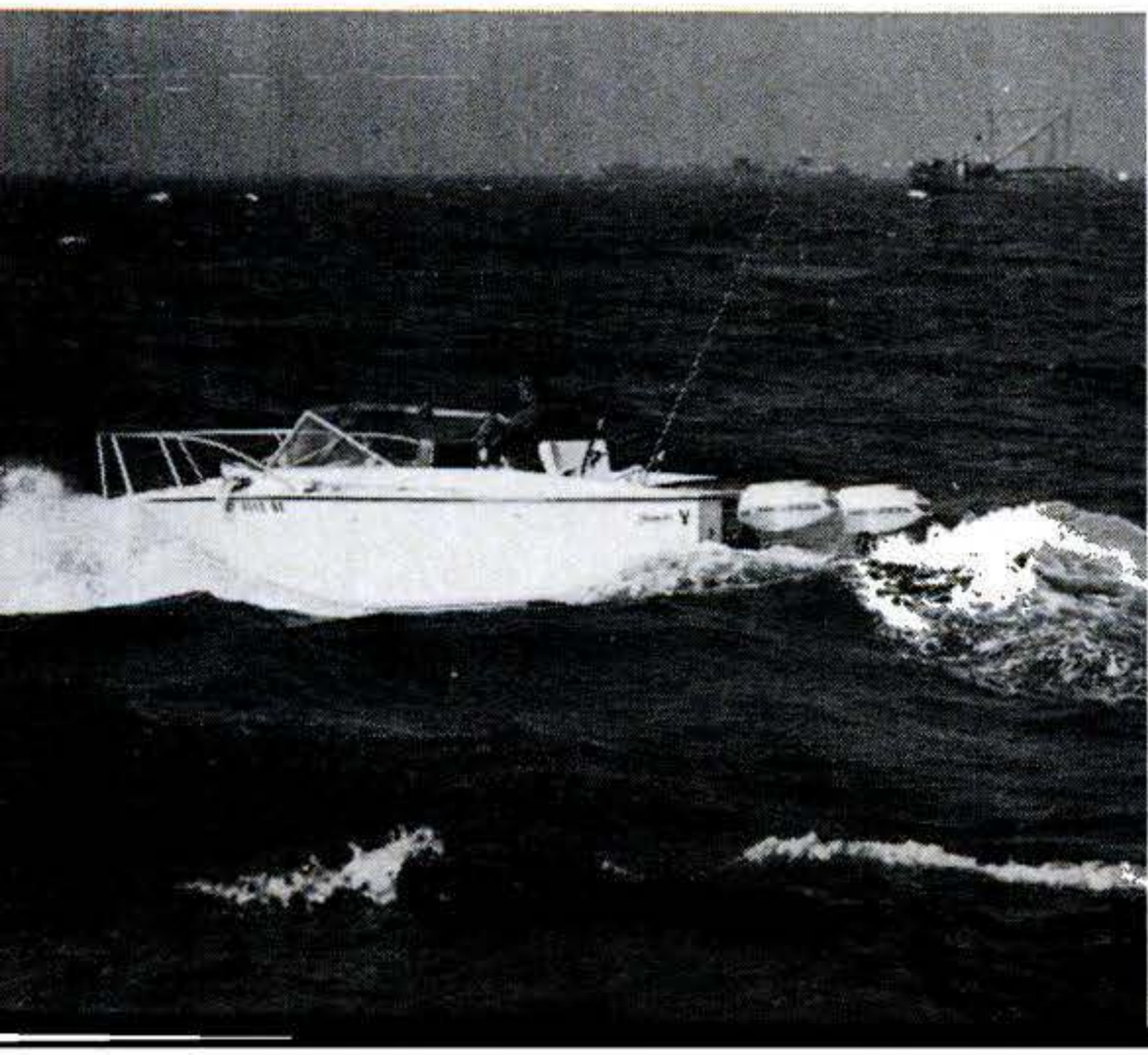
Steer slightly off-course a few points. Move your crew around. A 200-pound sailor hunched forward on the port side could tip you. The same man on the starboard quarter might let you bob.

How can you learn? Go out in a moderate chop and get the feeling of your boat's helm with normal weight distribution. Without changing course or speed, vary the stowage of heavy gear and seating.

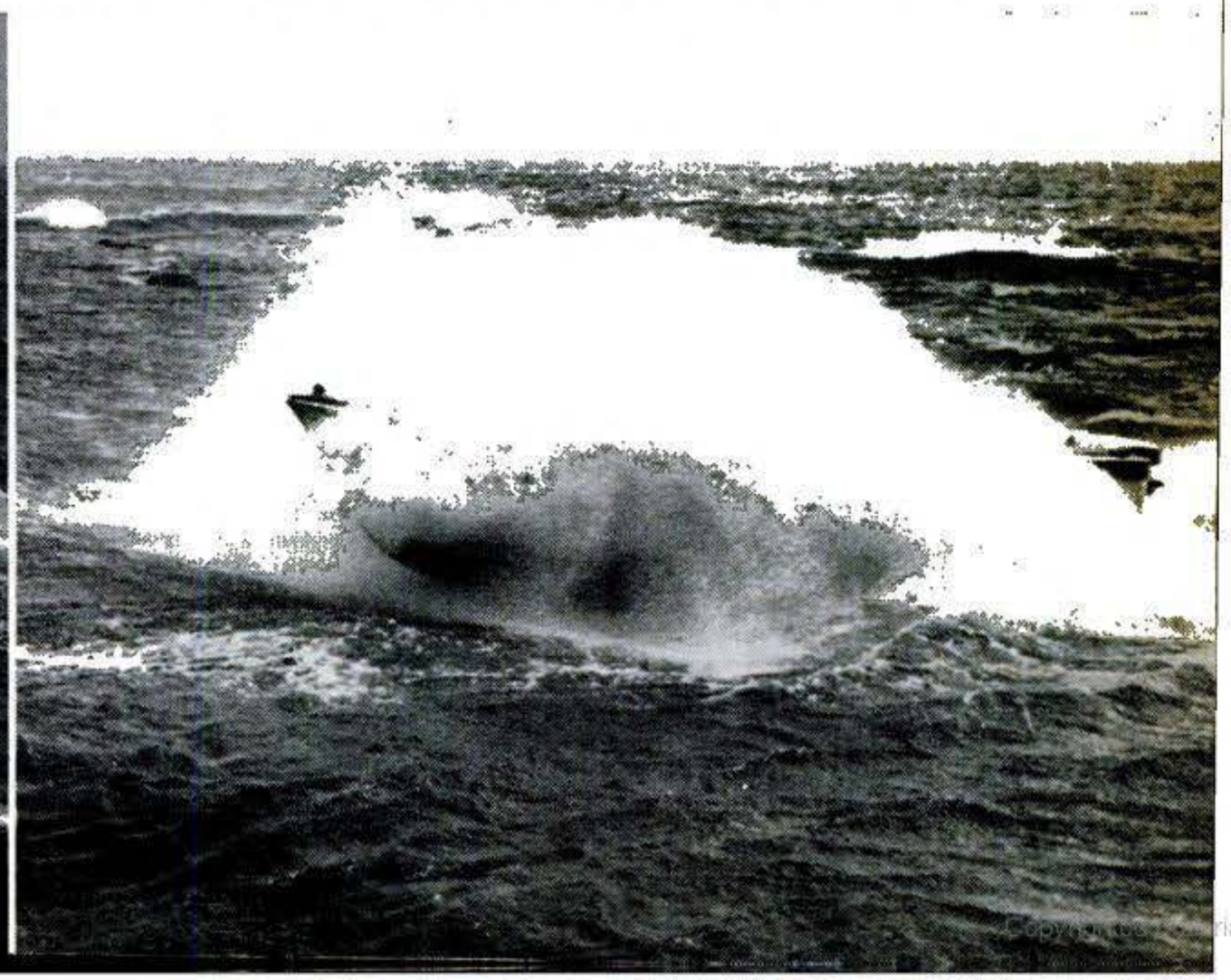
Wallowing in the trough. With both wind and waves hitting you broadside, you're liable to roll. If the propeller alternately rises up and drops back, it will race and

[Continued on page 185]

Deliberately overloading this outboard by placing several remote fuel tanks forward in a following sea, Chester Arthur illustrates a bow-heavy hull. It will "root" instead of rising easily on a wave. Trimming by equalizing the weight cures the trouble.

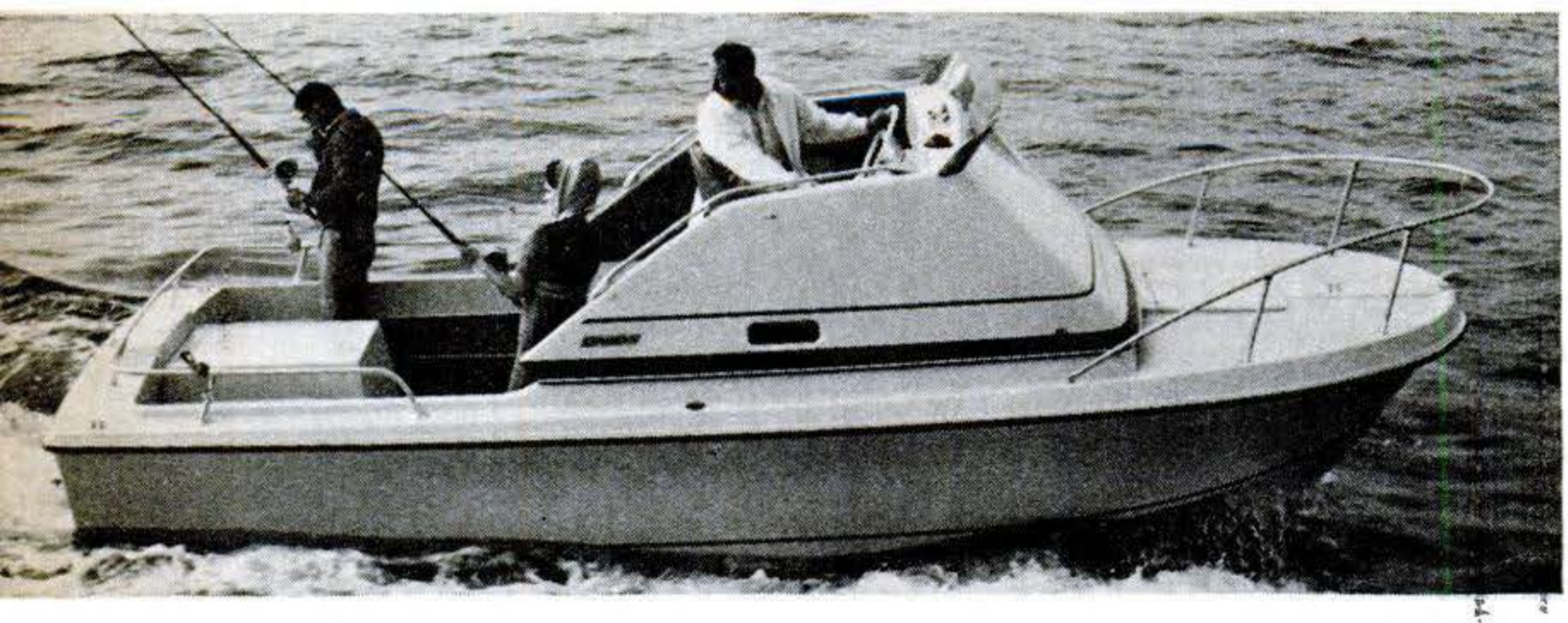


Fighting an inlet current at Quonochontaug Beach on the Rhode Island coast, this skipper gunned the motor to gain way. Result? The hull pounded and beat a course homeward—but the captain was unable to see at the helm. A nasty accident could result.



Flying saucer from England is the ultimate in powercraft simplicity—there's no provision for steering. You can put it through tight zigzags at high speeds merely by leaning into the turns. Only 7½ feet in diameter, the Circraft is all fiberglass (except for planing boards of marine ply) and takes any outboard up to 35 hp. in a well behind the cockpit. Cost in Britain: $240, from Bifort Engineering Ltd., Preston New Road, Blackpool, Lancaster, England.

WHAT'S NEW IN BOATING



Cockpit and cabin space is abundant aboard the Skipjack-20 Flying Bridge cruiser by Jack Cole Co., Costa Mesa, Calif. The cabin has two bunks, head, and optional galley. Toe-kick cockpit design lets fishermen stand flush. Power options from 160 to 210 hp.

Family-fun boat with flash is Glastron's 16-foot GT-160. There's a full 48 square feet of living area with generous hidden storage space below decks and under seats—and there's an 18-gallon bow tank. Other features: full flotation, mechanical steering, inland lighting, new Aqua-Lift hull to smooth the ride—and power to 110 horses.

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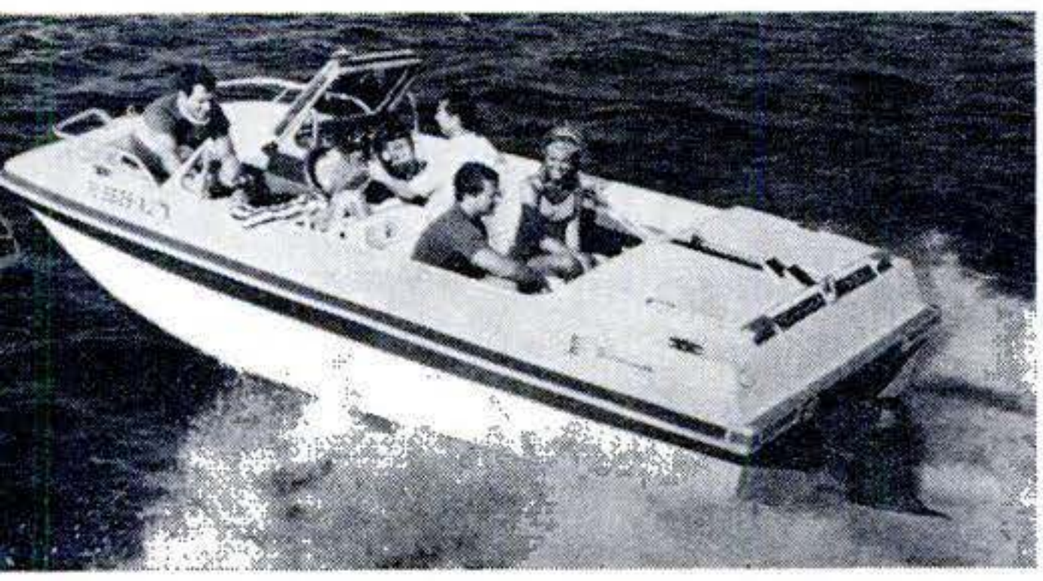
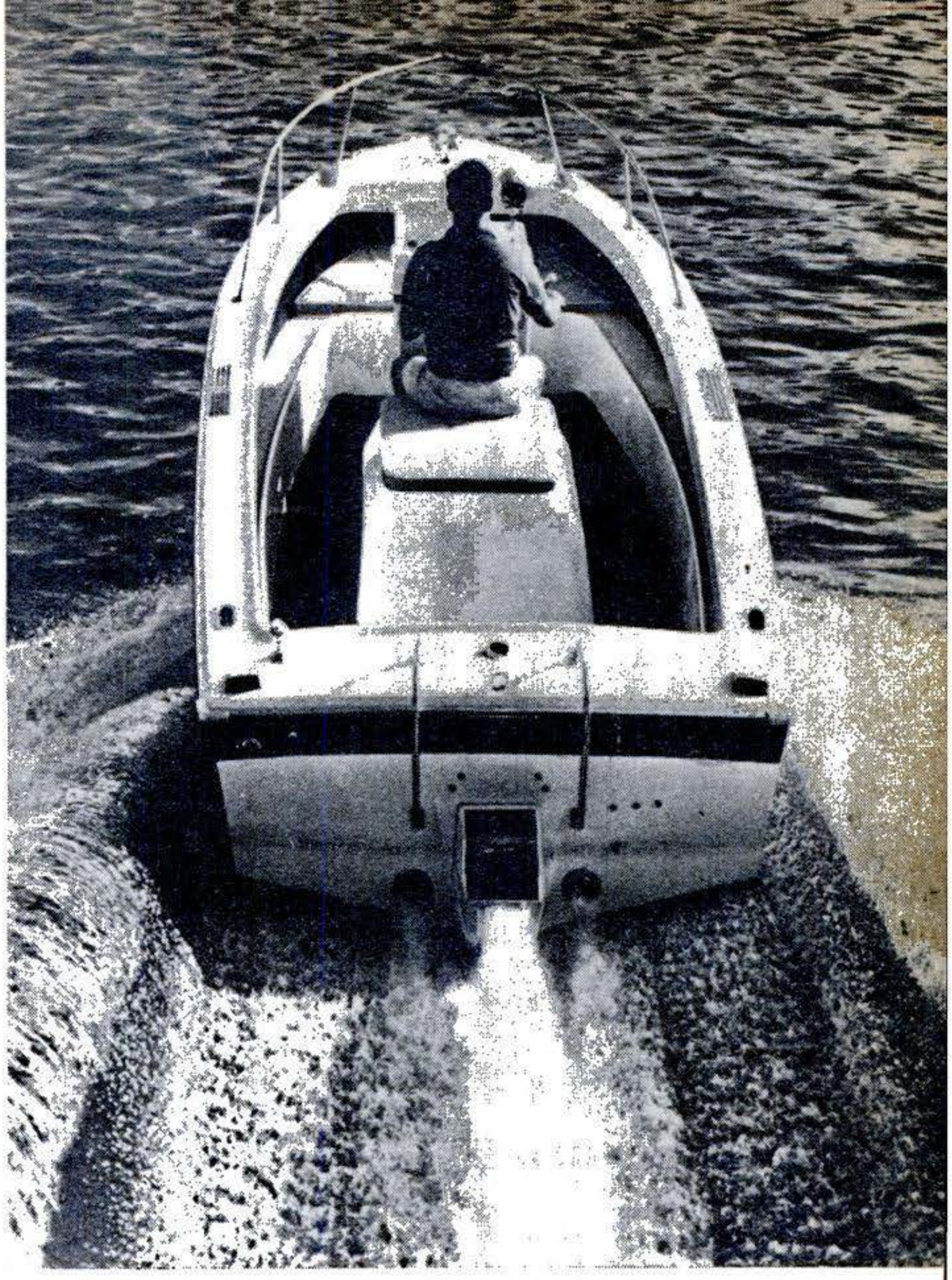
Four inches of water is all you need to get to hard-to-reach fishing and hunting spots in the 10-foot Arrow Jet 1000 air-drive boat. A Chrysler 10-hp. engine with 26-inch three-blade prop is housed in a fiberglass duct you rotate to steer—at speeds to 10 m.p.h. Arrowprop, Box 2339, Sarasota, Fla. 33577. $550.



Folding windshield of Evinrude's 16-foot Sportsman 155 gives easy access to forward cockpit—an ideal casting platform. Main cockpit has 54 square feet of space, full carpeting, convertible top, and back-to-back seats that open into lounges. A 155-hp. V-6 (or 120-hp. four-in-line) powers a stern-drive lower unit.



Open jet runabout from Buehler Corp. of Indianapolis, Nimrod II, has no prop to endanger swimmers. Wheel and binnacle are located midship of the 18-foot deep-V hull, providing easy access and storage for bulky sports gear. Full canvas for conversion to a camper is an option.

Radio direction finder and compass are combined in a self-contained, hand-held instrument for taking radio or visual bearings in all weather. Battery-operated receiver has large tuning scale. Seafix: $129, by Electronic Labs, 22 Leigh Rd., Ramsgate, Kent, England.

Great Lakes salmon and trout boom inspired Mirro Aluminum's 18-foot deep-V-bottom lapstrake Sports Fisherman. Swivel seat lets driver view all fishing action. Foam flotation under deck will float hull upright, even if swamped. Takes up to 125-hp. outboard. Mirro, 1512 Washington St., Manitowoc, Wis. 54220.

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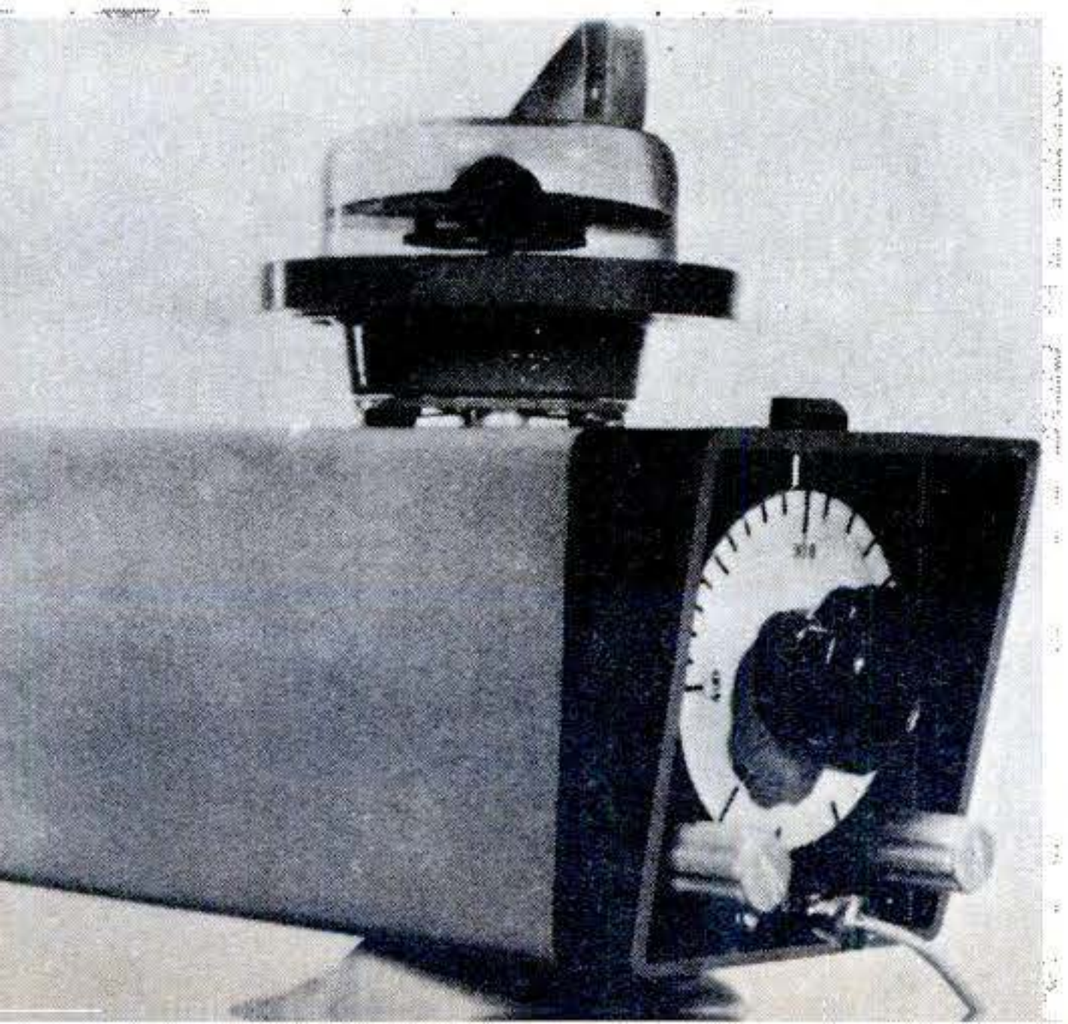
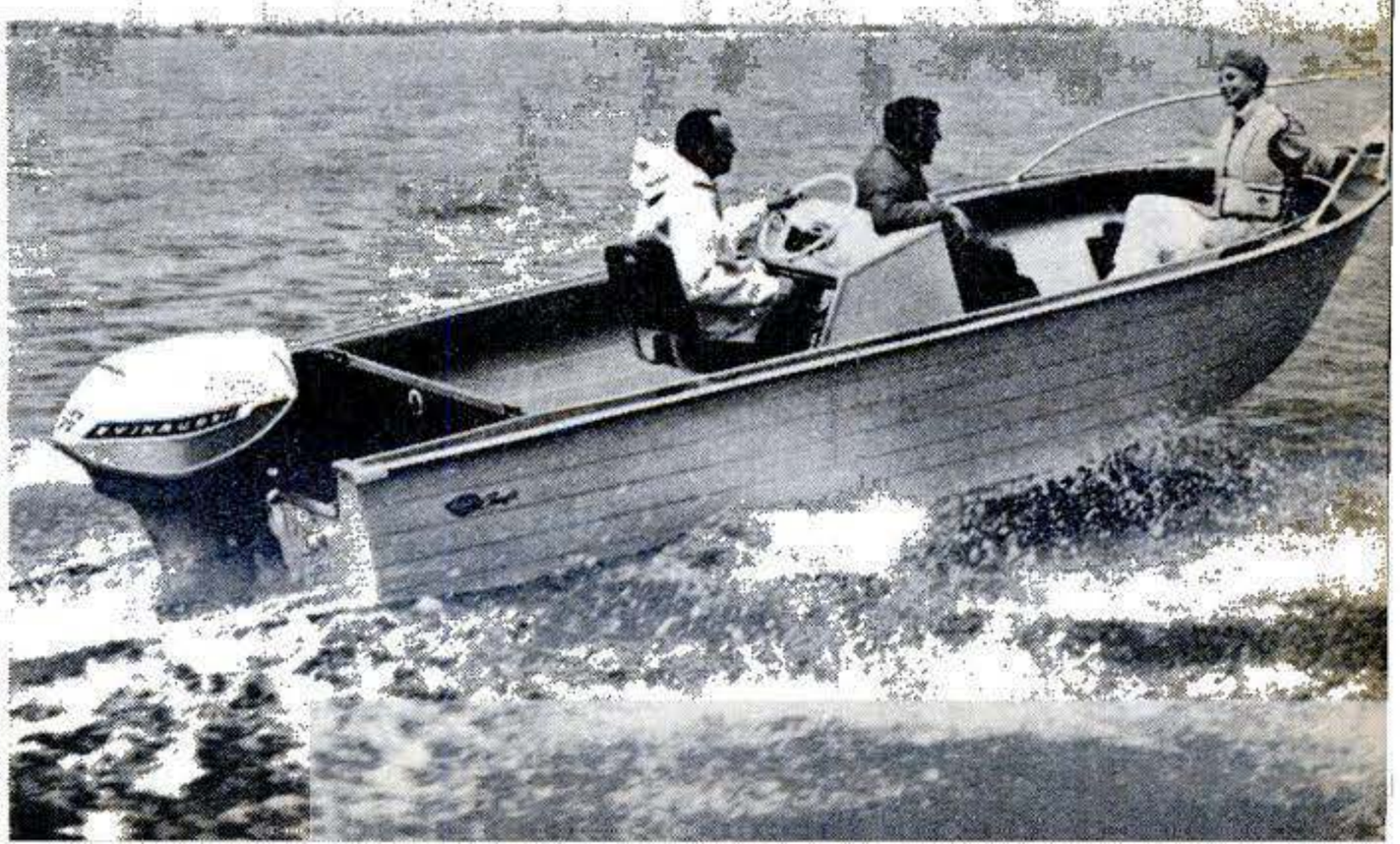
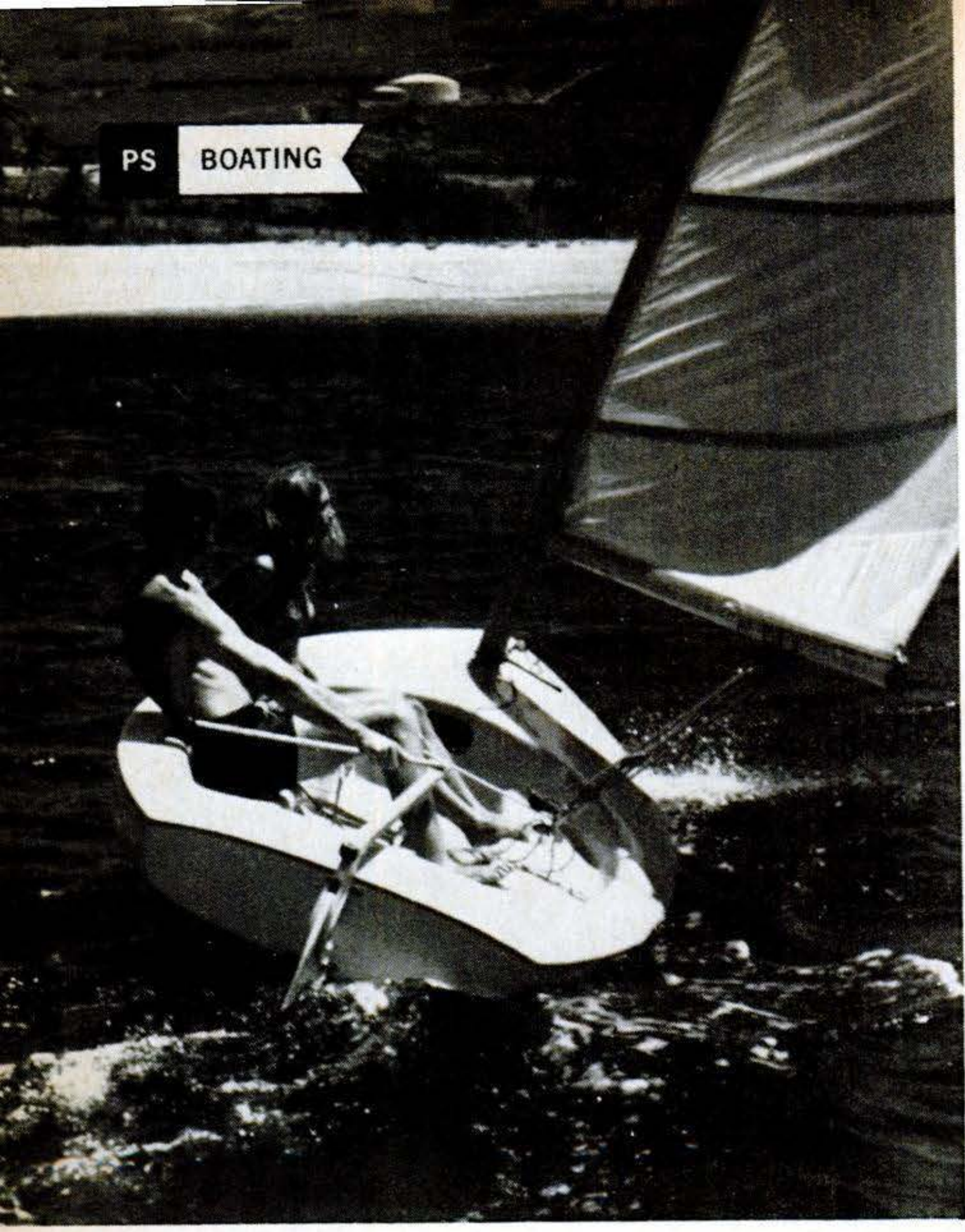
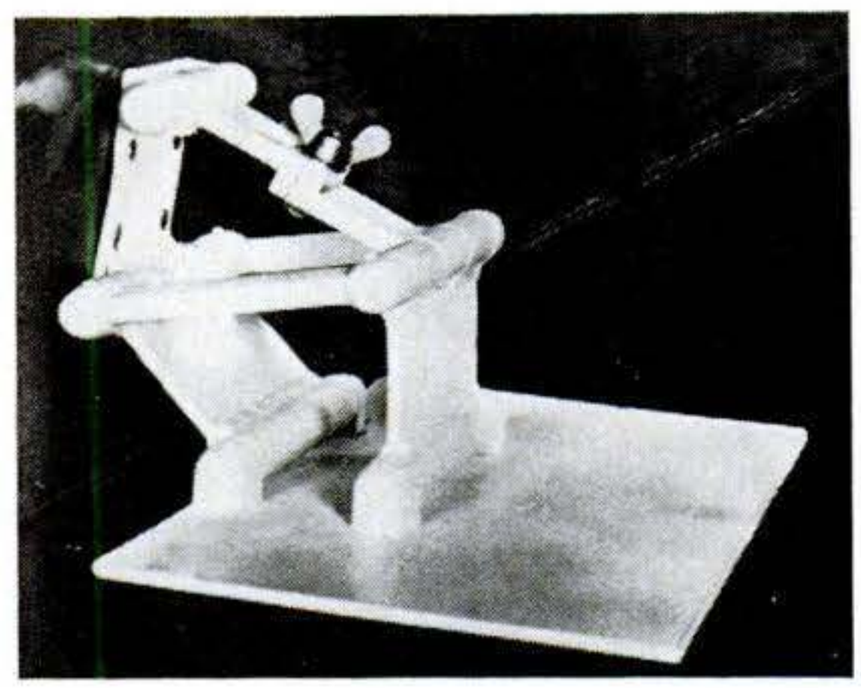






Sports sailboat, the 14-foot Dorado, new from AMF Alcort, joins the Sailfish/Sunfish line. Dorado features planing hull, fiberglass mast, flip-up centerboard and rudder, and forward storage locker. Foam flotation is bonded to hull. Boat carries four people, weighs only 190 pounds. AMF plans first deliveries for spring. Price: about $1,200.

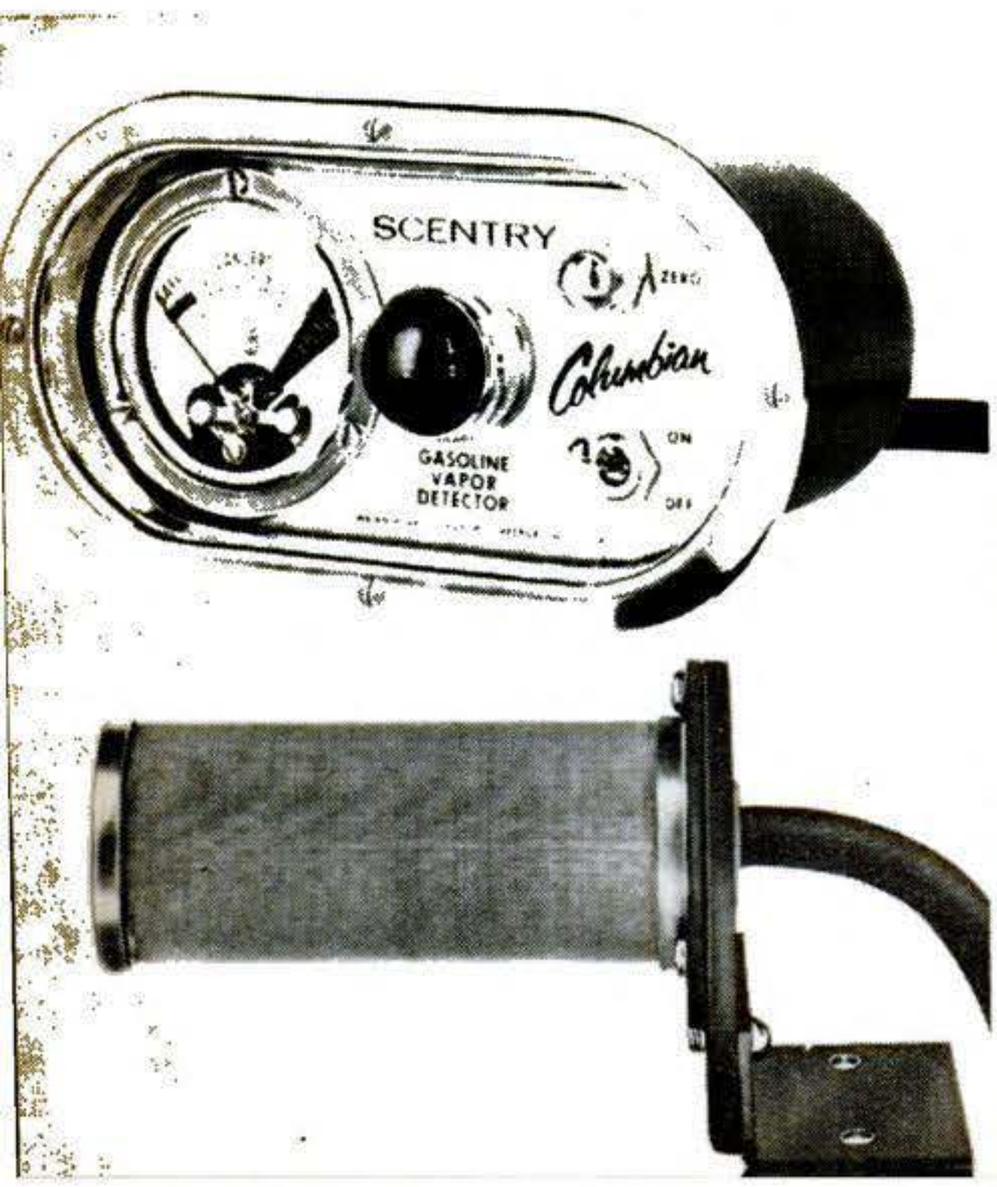


Automatic trim tabs, called Trim-Selvs, need no controls. Water pressure on tabs causes eccentric levers to change tab angle. Bolted to stern, they need be adjusted only when first installed. Swedish made; sold in U.S. by Trim-Selvs, 10835 E. Jefferson, Detroit 48214.

Vapor-gas detector, called the Scentry, warns of concentrations of gasoline, propane, butane, and alcohol vapors before they reach explosive levels. Made by Columbian Hydrosonics, Inc., Freeport, N.Y., the model CB-305A (shown below) sells for $69.50.

Ahoy, deck-swabbers, the new 10-quart Boat Bucket from Rubbermaid is for you. It has double pouring spouts and handgrips for easy use, and is made of durable plastic that won't scratch boat finishes. Great for cooling beer, and the $1.69 price tag shouldn't cause you any problem.

Protection from lightning damage is the claim of this easily installed grounding device, the deStriker. A wire uncoils from a reel and is thrown into the water to provide a ground for safety. From Marine Division, Export Corp., 8951 Schaefer Rd., Detroit 48228.



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FUEL for Your OUTBOARD

The right diet for your motor will keep it easy-starting, give it more power and a longer life. Here's the inside story from the experts

By WALLACE CLOUD DRAWING BY RAY PIOCH

Mechanics tell a story about a man who brought an outboard motor in for a tune-up and told the dealer, "You can fix anything that needs fixing, but whatever you do, don't touch that knob on the front of the motor. I've been adjusting that knob all summer, and I've got it to the point where it's absolutely perfect." Of course it was the knob that opens the cover of the motor.

There are other—and more real—adjustments you can make without ever looking inside the cowl. You definitely adjust the performance of the motor by the kind of gasoline and the kind of oil you use. But that adjustment can be equally haphazard if you don't know what you're doing.

Many of us have been raised on the gospel that you should never use anything but unleaded marine white gas in an outboard motor. But it's been getting more and more difficult to find any marine white. That's going to hit home even harder this boating season. A little-known fact, even within the industry, is that the Gulf Oil Co. has discontinued marketing its marine white, which was more widely distributed than others. Actually, the product was discontinued as of Jan. 1, 1968, although in some areas stocks were available through the 1968 boating season.

Of course a lot of people have been using automotive gas all along. Even if you don't fill your boat's tank at a service station on land, the "marine" gasoline sold at most marinas and gas docks is simply regular-grade automotive gas with an additive to cut down on gum formation during storage. It's reasonable to wonder what—if anything—that automotive gas is doing to your outboard motor.

Another homely dictum many people have been living by all these years is that you put a quart of oil in that gas tank along with six gallons of gasoline. That's a gas-to-oil ratio of 24:1. But in the last few years outboard motors have been appearing on the market with instructions specifying a 50:1 oil ratio, or even 100:1. The motor companies have been putting out mysterious special oil in cans the size of a beer can, or smaller, and that's what you're supposed to put in a six-gallon tank of gasoline.

What ratio? Questions inevitably arise: Can I use the same oil for an older outboard motor, and in the same ratio? Or, on the other hand, suppose I can't get any of that special oil—do I use ordinary outboard oil at a 50:1 ratio, or switch back to the older 24:1 ratio?

I've been discussing these questions with engineers who work for the outboard-motor companies, representatives of the petroleum refiners, and other out-

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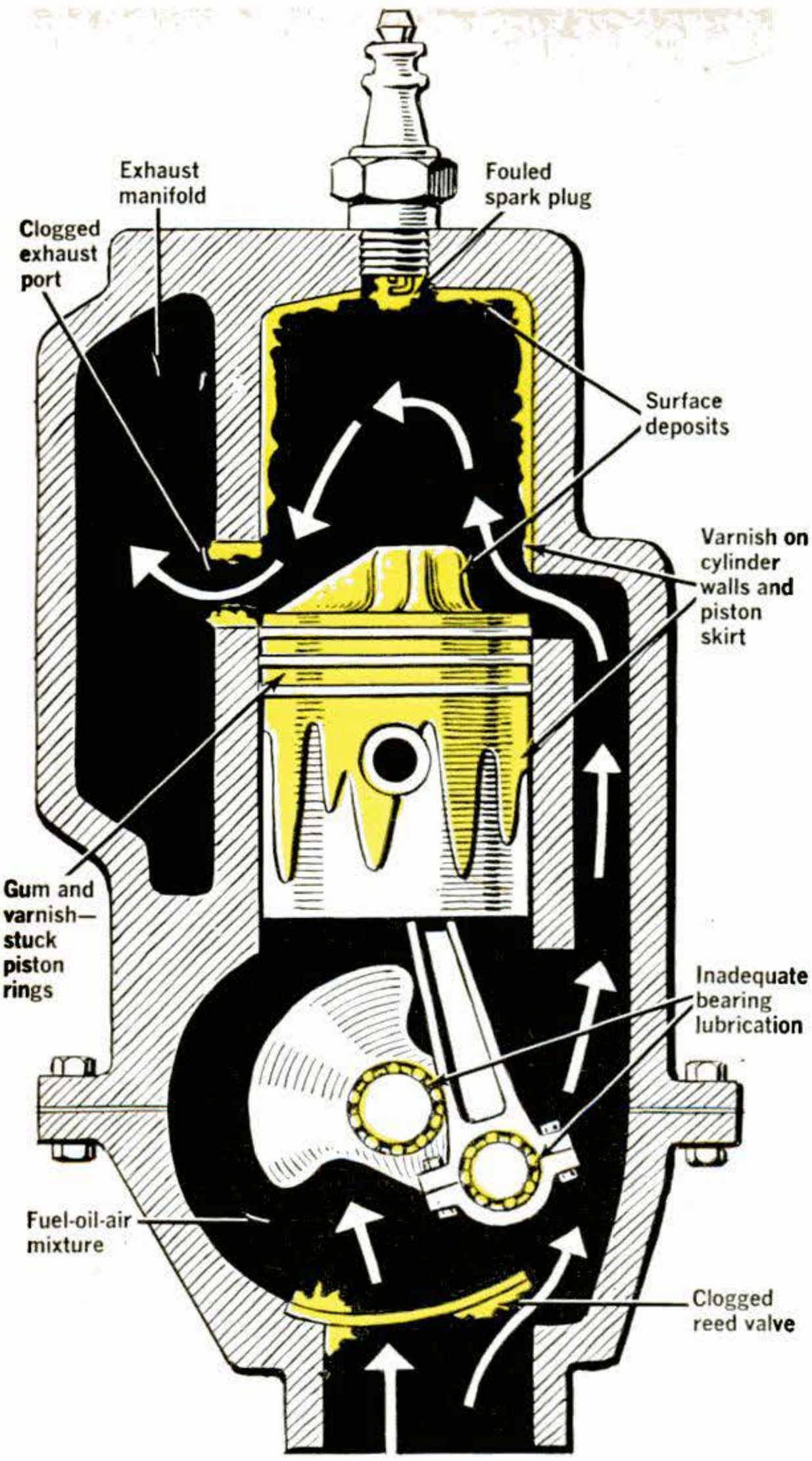

Two-stroke engine is vulnerable to poor fuel or oil at points along path of mixture through the cylinder. Reed valve is subject to clogging by gum in the gas. Connecting-rod and shaft bearings must receive adequate lubrication. Lead, additives, or unburned oil can foul the spark plug or leave deposits and varnish, causing pre-ignition, piston scuffing, stuck rings, clogged exhaust port.

board experts. There are some clear truths that apply to almost all outboard engines and the inboard-outboard drives that belong to the two-stroke engine category (Outboard Marine 90-hp. models).

The gasoline part of the story is fairly simple. You don't have much of a choice, since marine white is no longer available over most of the country. Does this make any difference to your motor? The petroleum companies say it doesn't.

For example, the Ethyl Corp., which produces much of the tetraethyl lead used in automotive gas to boost octane numbers, publishes an annual summary of the fuel recommendations specified by outboard-motor manufacturers for current engine models. In almost all cases these say, "Use marine white or regular-grade automotive gasoline."

But when I talked with E. L. Tandrup, an engineer for Ethyl, and mentioned that I'd heard that Mercury dealers in the East frequently advise customers to use the unleaded Amoco Super Premium gas, Tandrup said, "Sure, Amoco is the best—if you can get it and you're willing to pay the extra six cents a gallon."

I found that Mercury was not alone. Motor engineers said, "Don't attribute this to me, but . . ." and then went on to state the attitude which appears to be uniform throughout the industry: All outboard motors run better on a good-quality marine white gas.

One who was willing to be quoted was G. E. Miller, Manager of Technical Services for Outboard Marine Corp., manufacturer of both Johnson and Evinrude Motors. He said, "In general we would prefer that the customer use unleaded gasoline."

What about auto gas? The engines are also compatible with automotive gasoline, says Miller, but—"the additive tetraethyl lead can be harmful due to accumulation of combustion-chamber deposits, and spark-plug problems. Another additive that can be troublesome is phosphorus in the fuel." (This is included in some gasolines to combat the spark-plug fouling tendencies of lead in four-stroke engines.) "It can result in problems related to very short spark-plug life with certain lubricants, and also increase the tendency toward pre-ignition."

A number of additives used in automotive petroleum products are bad for your outboard engine, it turns out. Engineers stress that if you have to use automotive gas, you should use regular rather than premium. Premium gasolines contain a greater variety of additives and more of them. The exception, where it's available, is unleaded premium gas.

But it's better to use automotive gas, the experts say, than white gas of uncer-

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tain quality. Such gas is sometimes sold as "appliance gasoline" or "lamp and stove gas." While some low-horsepower, low-compression engines can run satisfactorily on this fuel, according to Kenneth R. Pike, Chief Research Engineer for Chrysler's outboard division, most engines will run quite "ratty," and it can damage more powerful engines. Low-lead light-aircraft gasoline is regarded as a good outboard fuel, by the way.

Spark-plug damage. Mercury recommends regular-grade automotive gas for their new larger engines fitted with Thunderbolt ignition and Polar Gap spark plugs. These surface-gap plugs run at lower temperatures than side-electrode plugs and are much less susceptible to fouling. "The use of leaded gas in smaller engines—35 hp. and under—has no major disadvantage other than reduced plug life," said a Mercury spokesman. But in the larger old-model Mercury motors with standard plugs, 1965 and earlier, leaded gas "can lead to damaging pre-ignition."

The problems are inherent in the nature of the two-stroke-cycle engine. Without separate intake and exhaust strokes, some of the combustion products are always left in the cylinder after each power stroke. Since a two-stroke engine is lubricated by oil mixed with the fuel, unburned or partly burned oil is part of the exhaust material that doesn't completely escape from the cylinder.

Thus the engine is sensitive to anything in the gasoline or oil that tends to build up deposits. Such deposits can foul spark plugs, or can form hot spots that cause the form of engine knock called pre-ignition. They can also lead to a buildup of varnish or gum in the cylinder, sometimes causing sticking of piston rings and ultimately, if the condition is severe, seizing of the pistons.

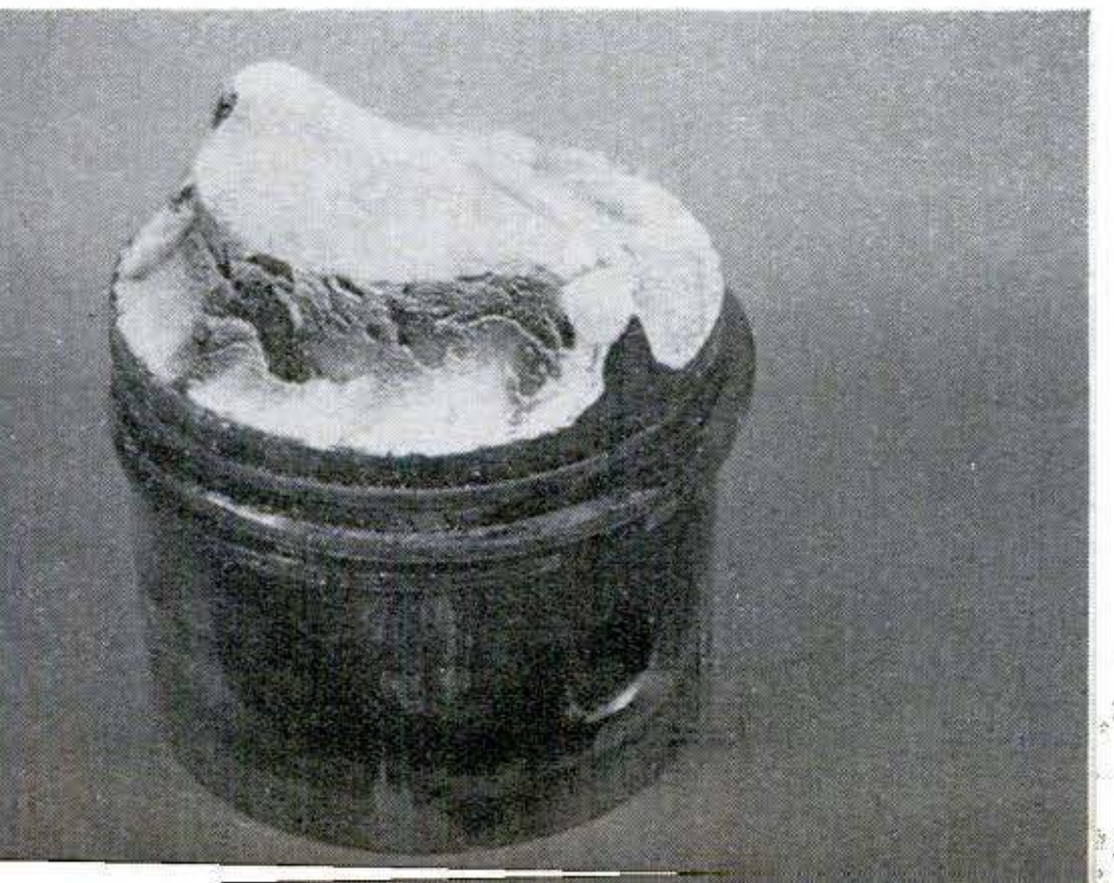
But all is not lost. When you talk to people in the outboard-motor field about fuel, the conversation shifts rapidly to the question of what kind of oil to use with the fuel that *is* available. It turns out that the oil you now mix with the gas has the role of modifying some of the detrimental effects of leaded gasoline. Outboard oil has also been improved in other respects.

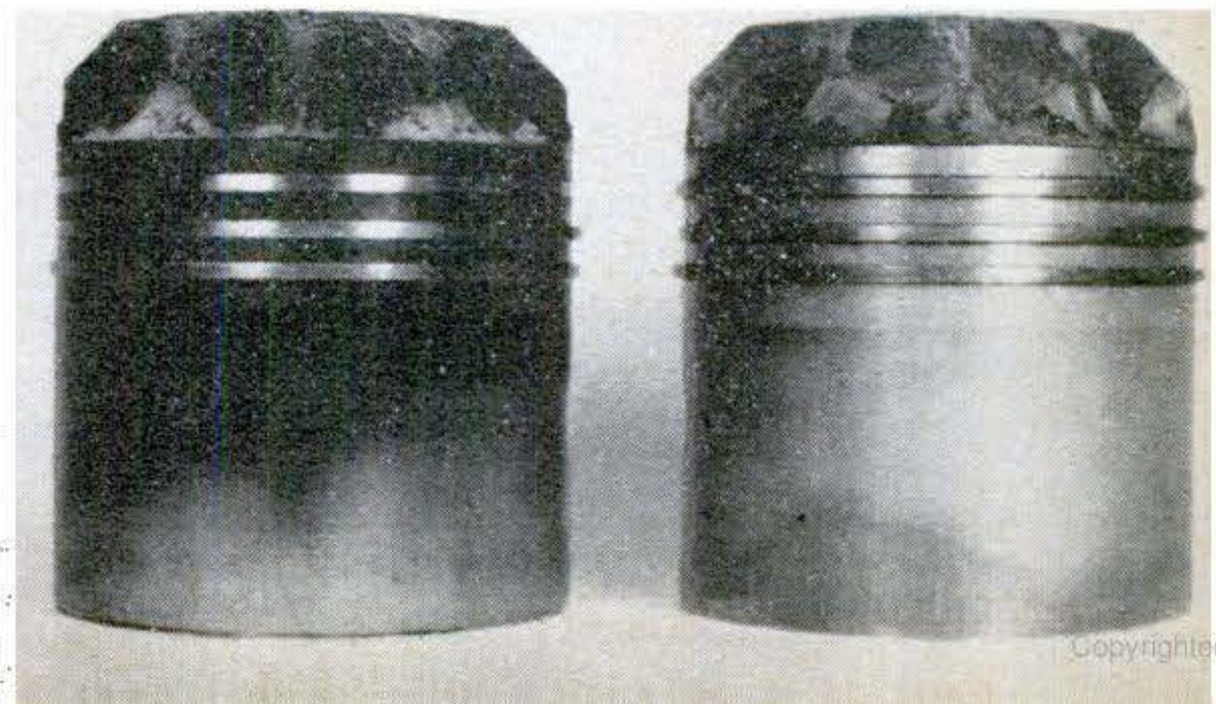
What's so special about the oil? Evidently it *is* special—everyone concerned with outboard-motor lubrication emphasizes that it is inadvisable to use automotive oil in your outboard engine. Automotive oil is designed to last a long time without breaking down at high temperatures, and does not mix well with gasoline. Outboard oil, however, is intended to have a short but happy life—to mix freely with gasoline and to burn rapidly and cleanly in the cylinder. Many automotive oils are also loaded with additives that are helpful in your car but leave damaging deposits in an outboard motor.

The 50:1 outboard oils also contain additives—but only those that are right for an outboard motor, combined with a clean-burning base stock. The additives are the kind called detergents or disper-

[*Continued on page 189*]

Value of "ashless" 50:1 oil is shown in photos below from Outboard Marine labs. Typical buildup of deposits and varnish on piston at left is due to "commercial" outboard oil, containing ash-forming metallic detergents. At right, note contrast with clean pistons lubricated by oil containing ashless detergent. Each major outboard engine manufacturer sells such special 50:1 oil.





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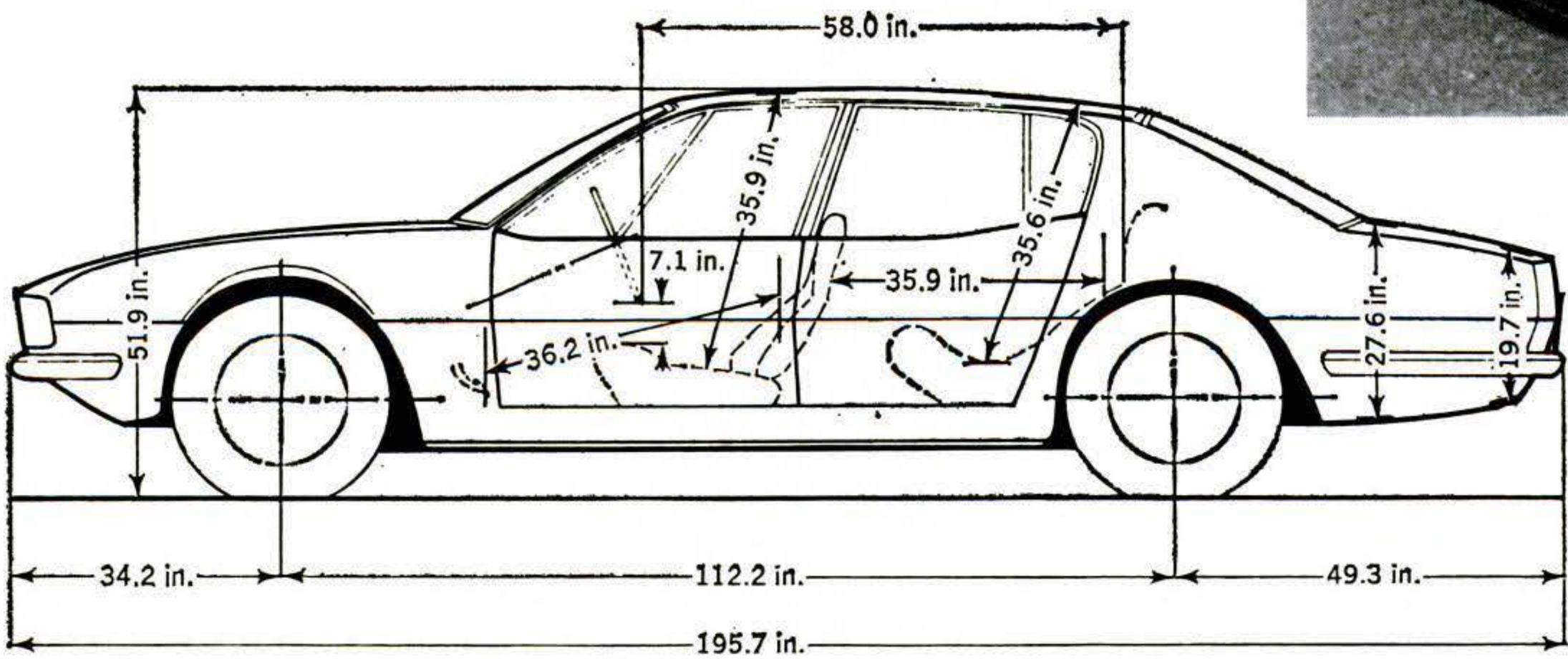
Did Chevrolet miss a bet by not making a combined limousine and sports car, such as the Iso S-4?

Corvette-Powered Family Car from Italy

By JAN P. NORBYE / *PS Automotive Editor*

Returning from test drive, Norbye (five feet, seven inches) looks down on sleek S-4 sedan, admiring its clean, functional styling. Hood is a short, slightly curved panel that blends perfectly into fenders.



Not a wasted cubic inch inside body shell, is author's conclusion after thorough examination.

What's so sensational about this car is not its performance but its architecture. Even so, it rivals the Maserati Quattroporte for the title of Fastest Four-Seater in the World, with a top speed of some 140 m.p.h. and a standing quarter-mile elapsed time of under 15 seconds.

What do I mean by architecture? The overall design, space utilization, interior layout, driver visibility, and front and rear overhang. The overall dimensions of the car are modest, yet the inside is very roomy. It has shaken up the world of auto stylists, and some of its design elements are already appearing on new models from other companies.

The drawing above shows you the ample interior dimensions. It doesn't show the plushness of the anatomically designed seats, and the Rolls-Royce-like refinement of the entire passenger compartment. With an overall width of only 70 inches, the S-4 has as much hip and shoulder room as most full-size American cars. And look at the figures for head room and leg room!

How has this been possible? First of all, the hood is short, which brings the windshield base and front seats forward. Secondly, the rear seat has been pushed back so that the top of the seat back partly covers the final drive unit. Since there is no rear axle but a sophisticated De Dion rear-suspension system, this positioning of the rear seat has brought no penalty in ride comfort.

The ride, as a matter of fact, is about as firm as in an Impala with heavy-duty

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Inspiration for Detroit sedans of the 1970s? No doubt many of its features will be adopted.

suspension, and somewhat quieter. The low overall height is a result of stretching out the whole passenger compartment. You sit less upright than in an American car, but lean back, more relaxed. And all this has been accomplished with a 112.2-inch wheelbase, only fractionally longer than a two-door Chevelle's.

Since the Iso S-4 is craftsman-built, the cost is several times higher; list price is $13,875.

The trunk is deep and spacious, and the vast glass areas assure tremendous all-around visibility. The windows seem to reach into the roof—an impression you get from the curvature of the side windows and the unusually rakish angle of both windshield and rear window.

The standard engine is the 300-hp. 327-cubic-inch unit that was standard in the Corvette 1963-1969, and more powerful versions are contemplated as soon as Chevrolet will deliver them. Transmissions are manual four-speed or Powerglide (Turbo HydraMatic will be available as soon as General Motors can supply it).

Disk brakes are fitted on all four wheels, with larger swept area than in the Corvette. Power steering is optional (Iso has its own system, with very little assist at high speed, and full assist for parking).

The designer's name is Giugiaro (pronounced ju-*ja*-ro) and the steel body is built by Bertone. The U.S. distributor is Skip Callanan, American Granturismo, Inc., 23 West Ave., S. Norwalk, Conn.

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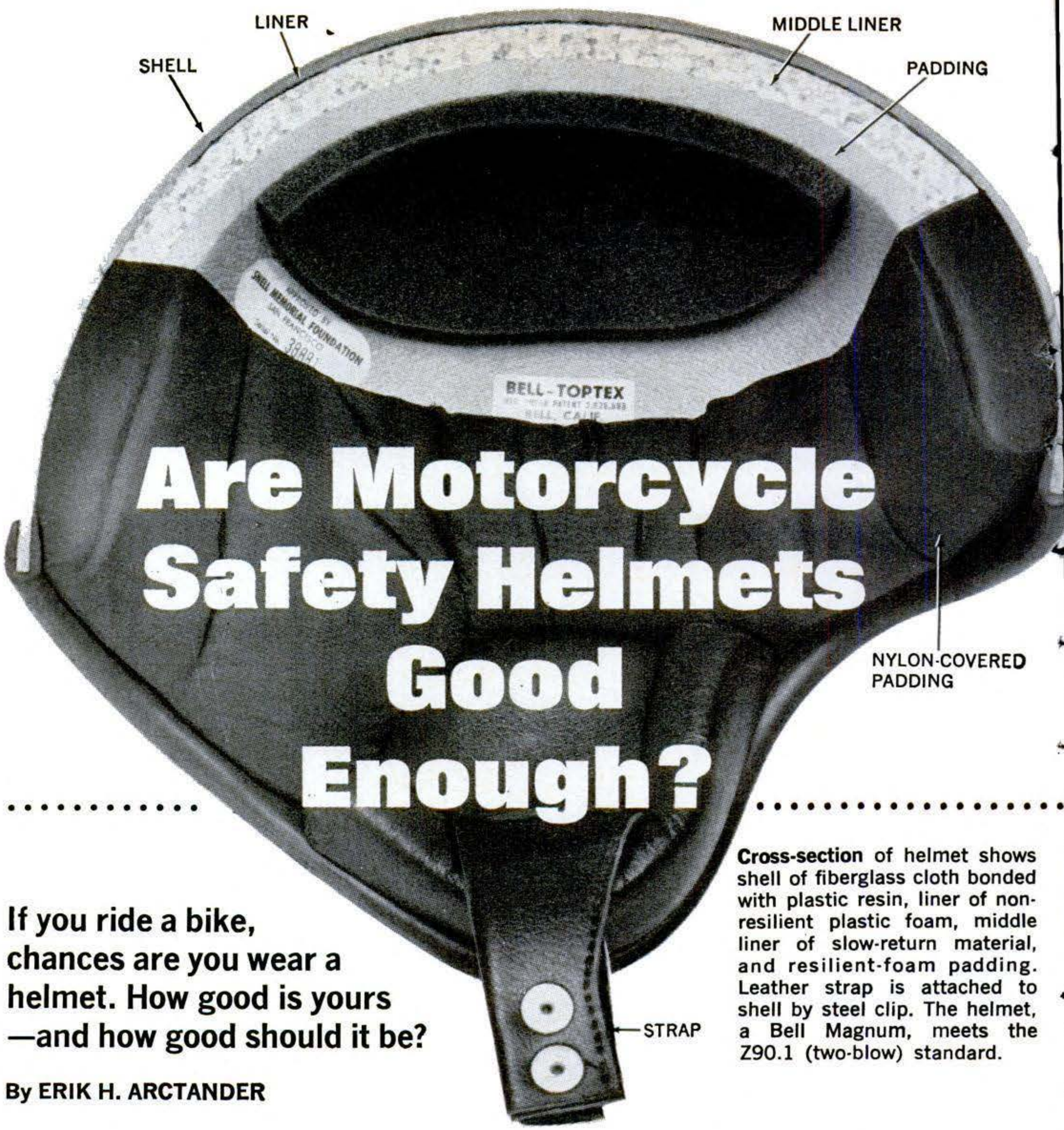

Are Motorcycle Safety Helmets Good Enough?

Cross-section of helmet shows shell of fiberglass cloth bonded with plastic resin, liner of non-resilient plastic foam, middle liner of slow-return material, and resilient-foam padding. Leather strap is attached to shell by steel clip. The helmet, a Bell Magnum, meets the Z90.1 (two-blow) standard.

If you ride a bike, chances are you wear a helmet. How good is yours —and how good should it be?

By ERIK H. ARCTANDER

Pete Snell spun the wheel over and drifted into the curve. Suddenly another sports car slammed into the back of his machine, flipping it over and over. Several hours later Snell died of massive brain damage. His helmet, shattered, had tragically failed him.

The Snell Memorial Foundation was born of that 1956 racing tragedy in Arcata, Calif. It brought the first thorough scientific investigation into head protection in the United States. What the Snell Foundation has learned since then about head injuries and helmets promises to benefit every American who risks brain damage and death through accidents.

Drivers who race sports cars, motorcycles, racing cars, hot rods, stock cars, and speedboats are already better protected because many of their associations urge or require them to wear Snell-approved helmets.

But the largest group of helmet wearers—over 1½ million—are road-riding motorcyclists. Today 38 states require drivers and passengers on two-wheelers to wear head protection. A dozen years after Pete Snell's death you'd expect these state laws to ensure the best helmets for motorcyclists that modern science and manufacturing can produce. Unfortunately, it hasn't worked out that way.

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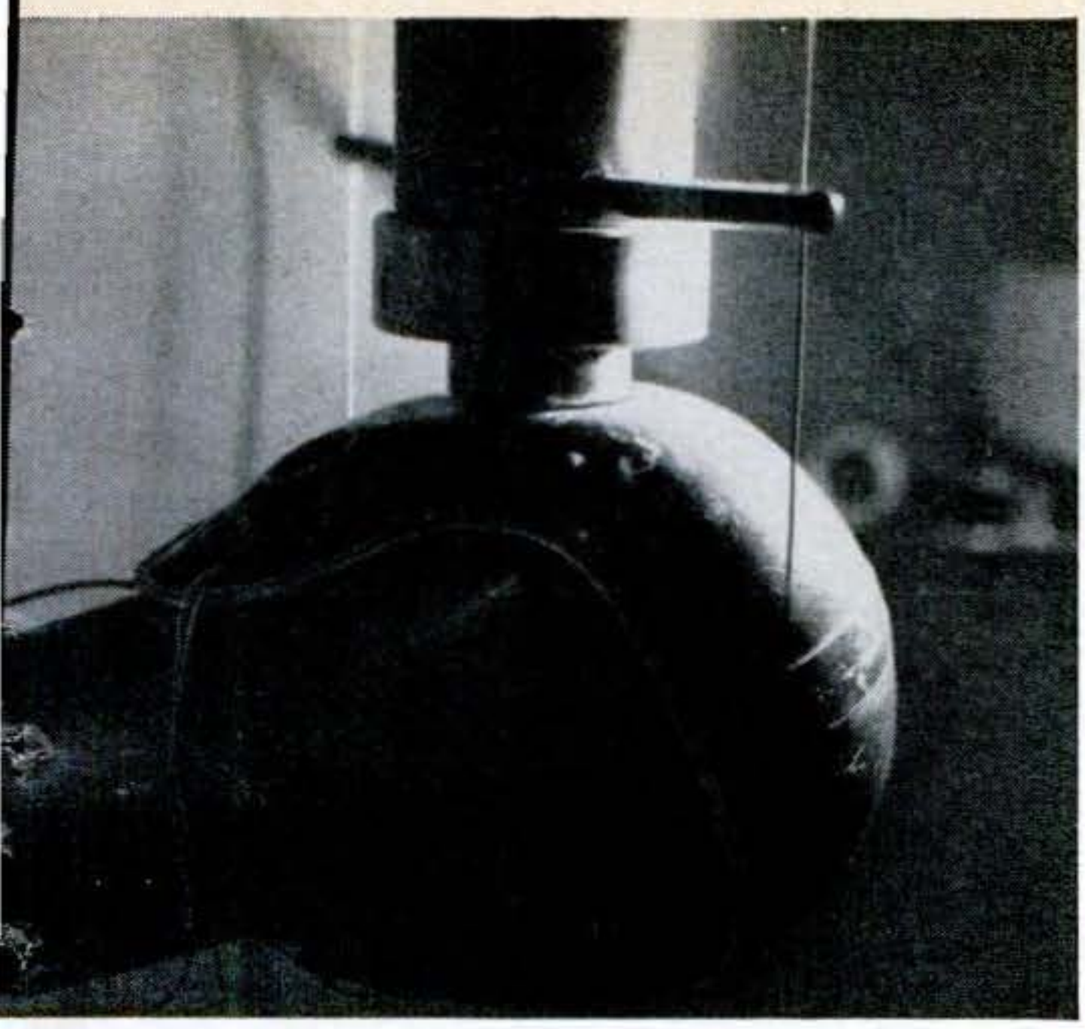
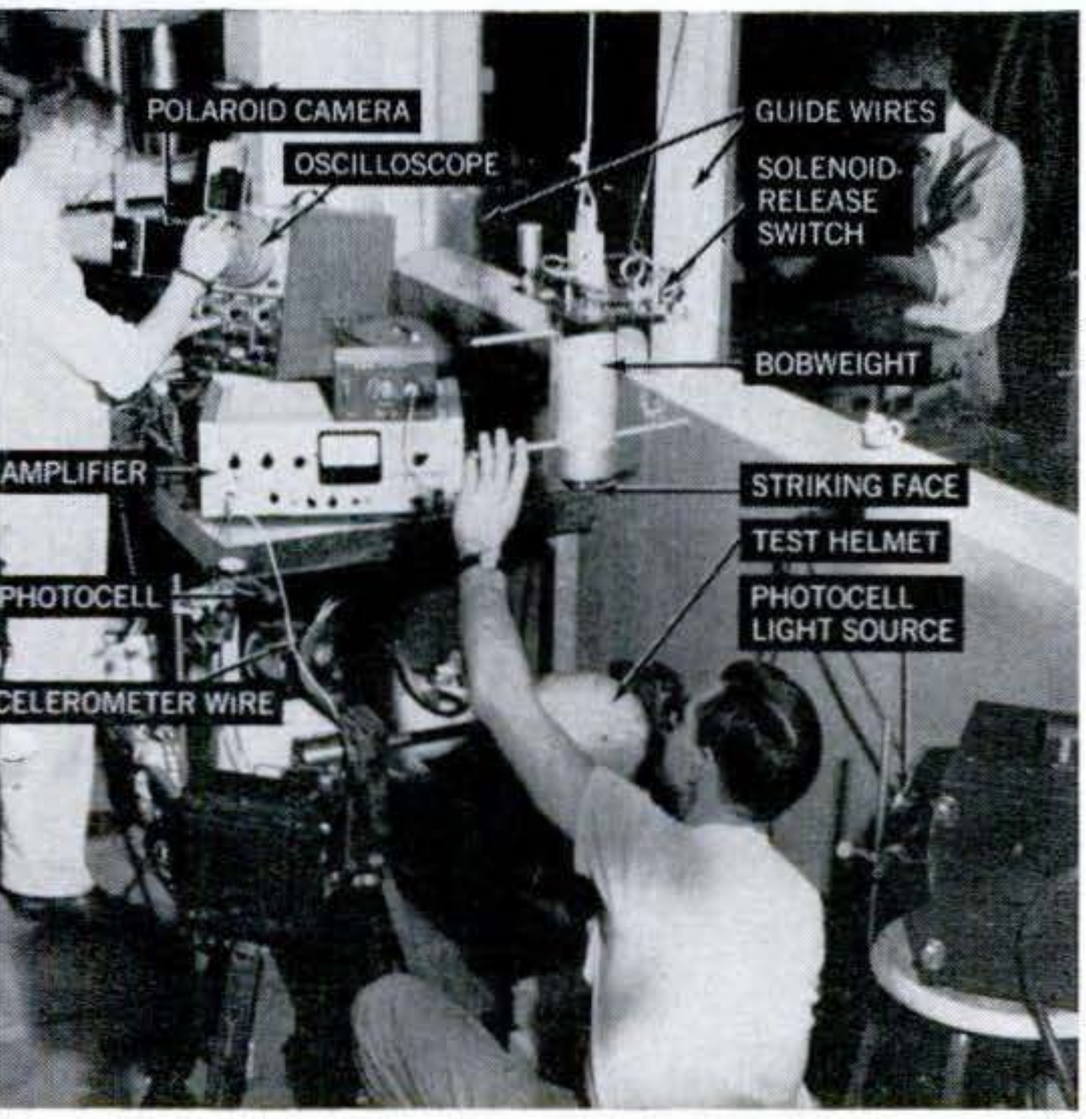
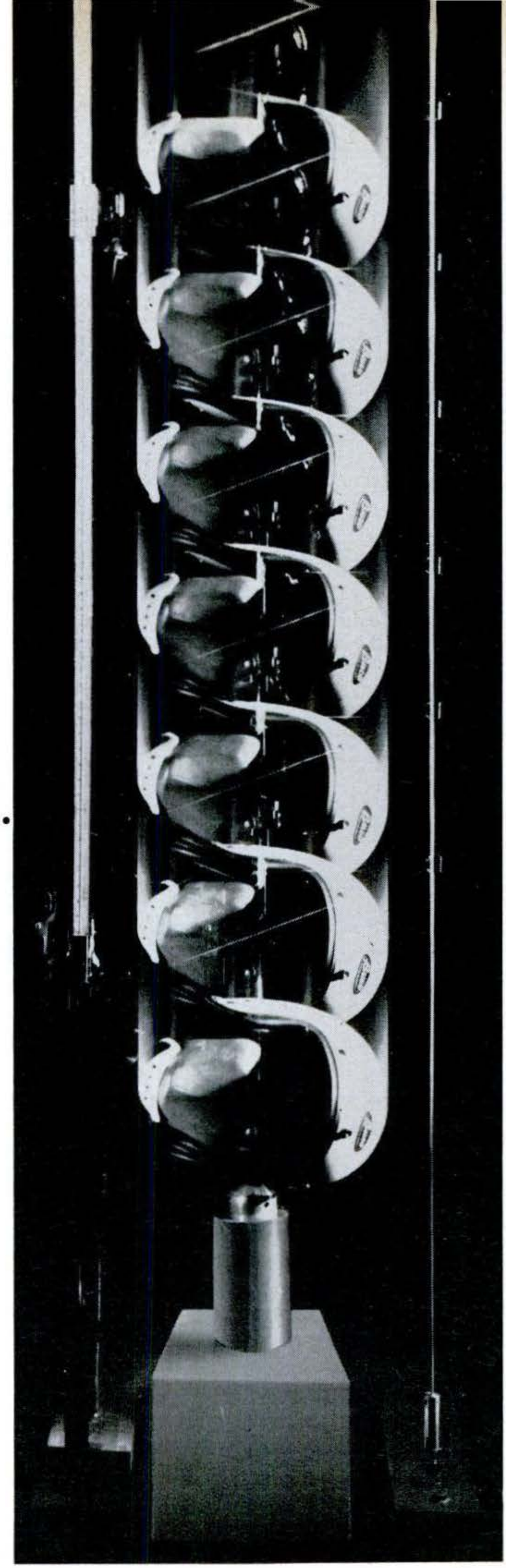


Helmet-testing methods vary. At Snell Foundation bobweight is dropped on helmeted form attached to pivoting arm; glass rod supports arm until sheared by impact of falling weight. The 2,000-frame-per-second photo shows striker indenting helmet. Buco (right, in strobe photo) drops helmeted form on fixed anvil. Snell says pivoting arm simulates flexibility of wearer's neck; Buco says moving helmet strikes fixed object in most accidents. A 120-foot-pound impact by Snell method imparts same acceleration to head form as 50-foot-pound impact by Buco method.



Raised to proper height by wire rope and winch, bobweight is released by activating solenoid. As bobweight falls it intercepts a light beam, triggering an oscilloscope. Striking helmet, the weight causes a glass rod holding the pivoting arm and head form to shear. Arm and head form swing freely, activating an accelerometer. A signal from the accelerometer is amplified and fed into an oscilloscope, where it appears on a screen and is photographed.



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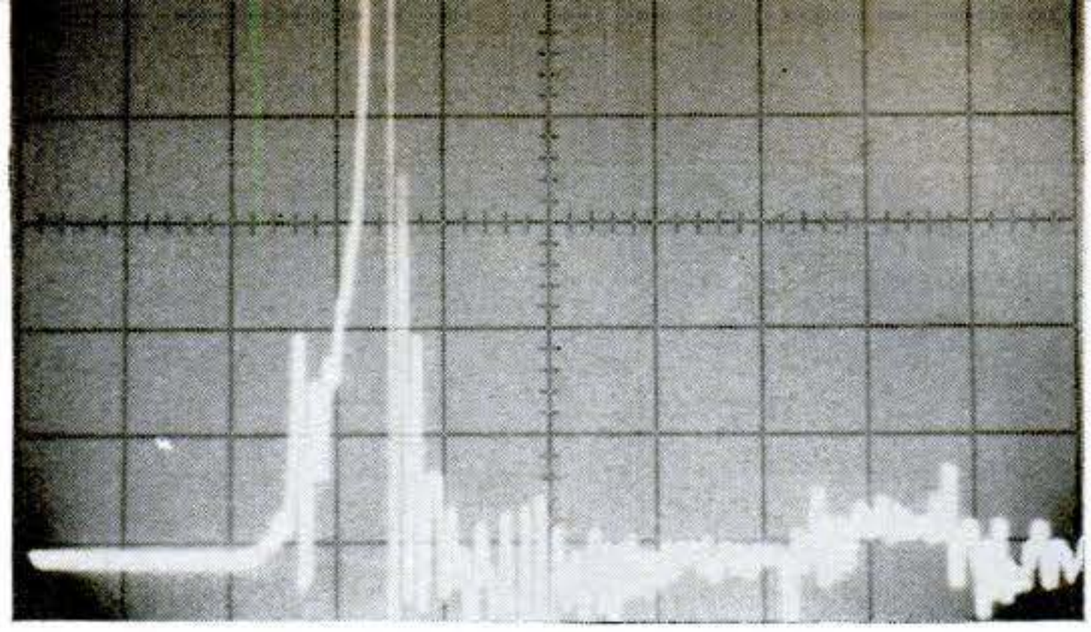
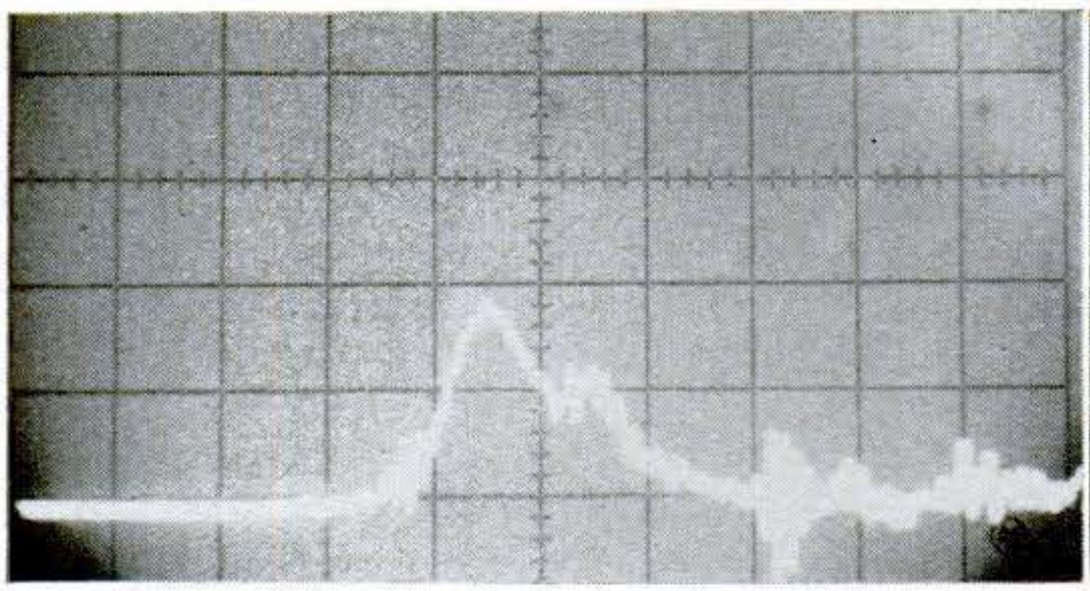
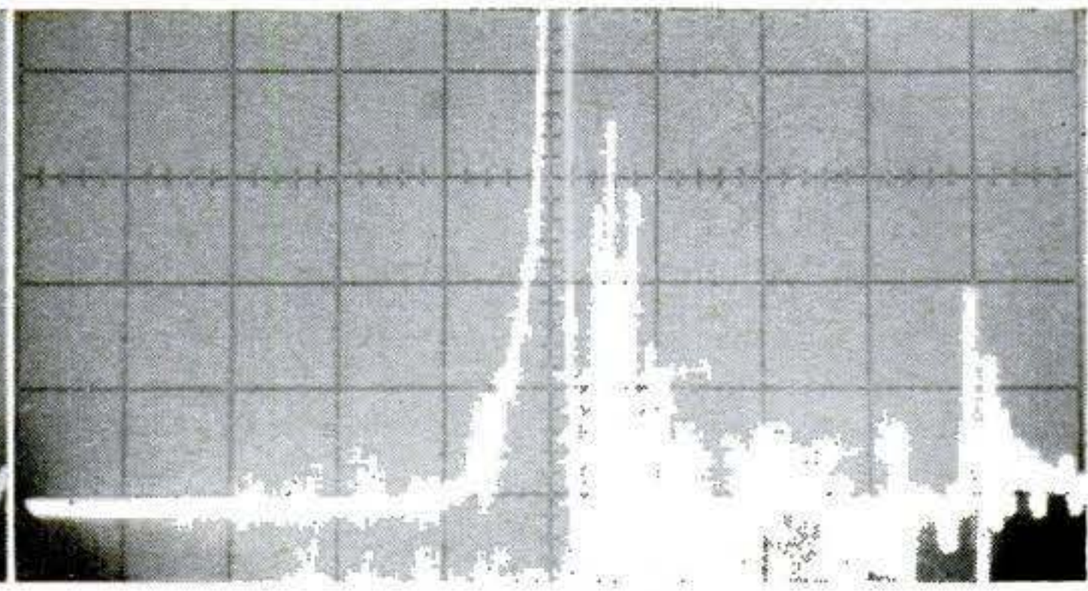
Oscilloscope traces decide which helmets pass test—or fail

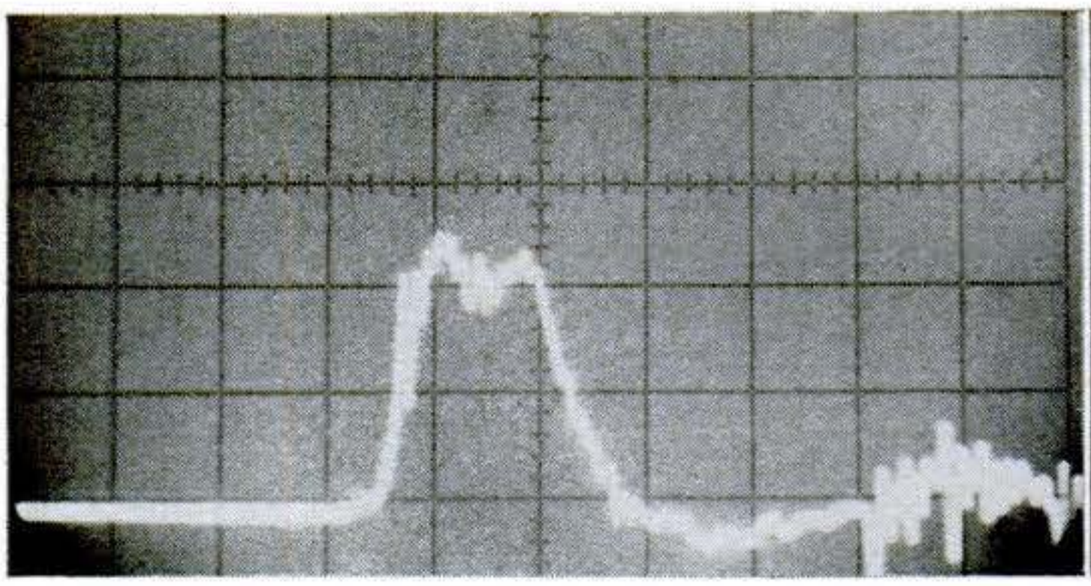


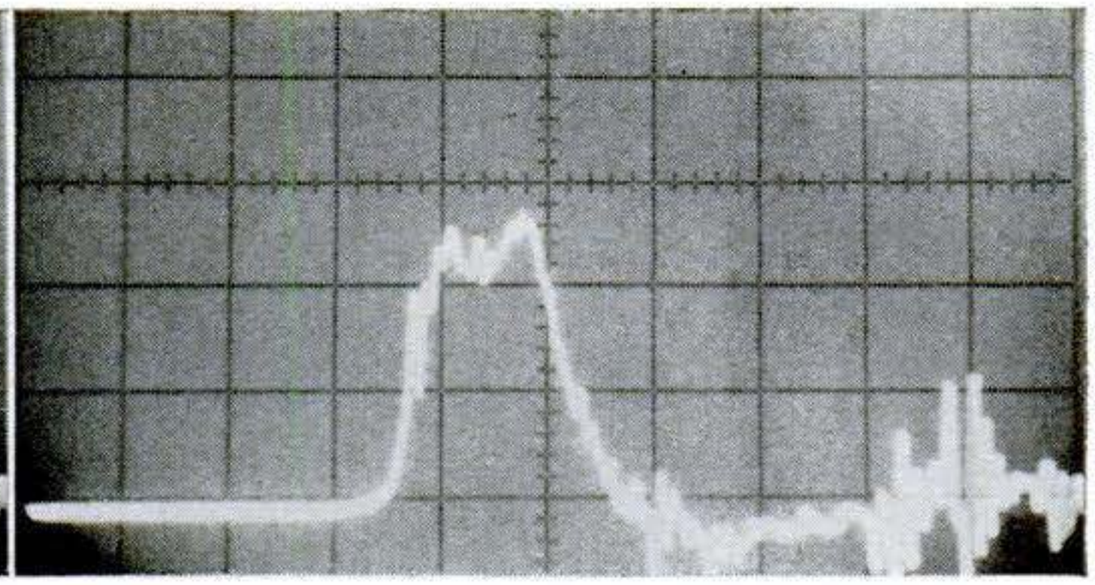
This helmet flunked on the first blow. The trace (right) shoots off the oscilloscope screen, indicating head acceleration of over 450*g*. The brain would have slammed against the inside of the skull causing fatal or near-fatal concussion. Each vertical division on the screen equals an acceleration load of 60*g*; each horizontal division, two milliseconds.





Passing the first blow (above), this helmet failed the second one, as shown at right. Testers watch for duration of the excessive acceleration as well as maximum acceleration. A helmet is rejected as unsafe if peak acceleration exceeds 400*g* or acceleration between 200 and 400*g* persists for more than two milliseconds. Acceleration exceeding 150*g* is not tolerated for more than four milliseconds.





Third helmet passed both blows satisfactorily. In addition to acceleration tests, helmets must pass shell-penetration and harness-strength tests after being immersed in water, heated, and frozen.

A scientific argument—still unsettled—divides the experts, leaving federal and state law makers confused. The argument began three years ago when two events coincided.

First, the Z90 Committee of the American Standards Assn. (now the U.S. Standards Institute) published specifications on "protective headgear for wear by riders and occupants of vehicles engaged in potentially high-hazard activities." Shortly afterward, the Federal Highway Administration advised all 50 states to require that motorcyclists wear "approved safety helmets" when riding on public roads.

Approved by whom? State legislatures quickly began enacting helmet laws, but stumbled over the word "approved." Federal safety experts offered no specifications for the helmets, and three years later have yet to do so. In the absence of federal guidelines, the legislators and state highway officials turned to the Z90 Committee and its new standards. Dr. George G. Snively, chairman of the Committee and research director of the Snell Foundation, recommended that the states adopt the Z90.1 helmet standards.

Snively was soon challenged by Prof. Lawrence M. Patrick of Wayne State University, a fellow member of the Z90 Committee and a technical consultant to the maker of Buco helmets for almost a decade. Z90.1 with its two-blow standard (see captions) was devised for competition racers, argued Patrick, not for ordinary motorcyclists on the roads.

"What Z90 established," insists Snive-

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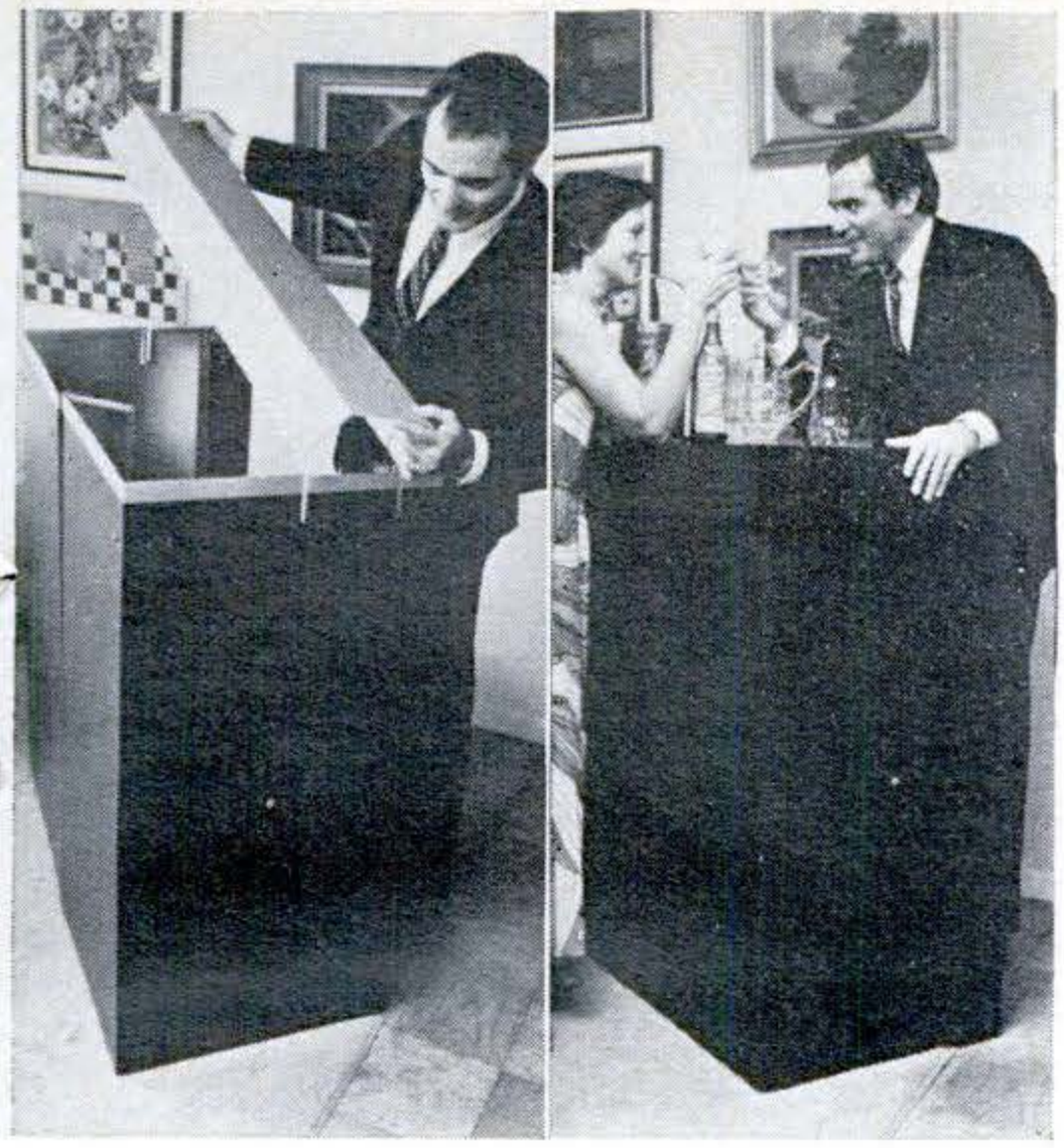
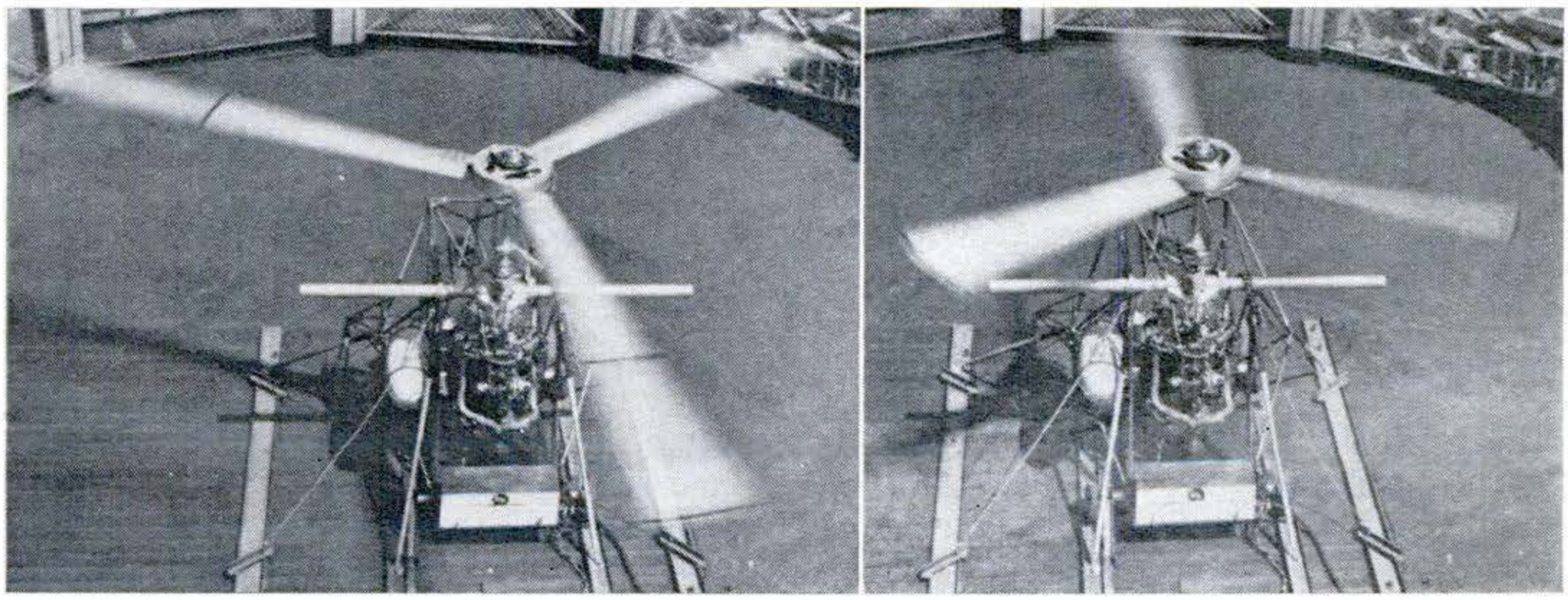


Collapsible bar is made of paper

This party bar folds into a compact package for storage, and can be assembled in a few minutes into a 42-by-43-by-22-inch serving unit. Made of kraft paper, coated with liquid-repellent plastic, the bar can be used indoors or out, weighs only 11 pounds, but can support 200 pounds. The Port-A-Pub, made by Scott Paper Co., sells for $19.95.

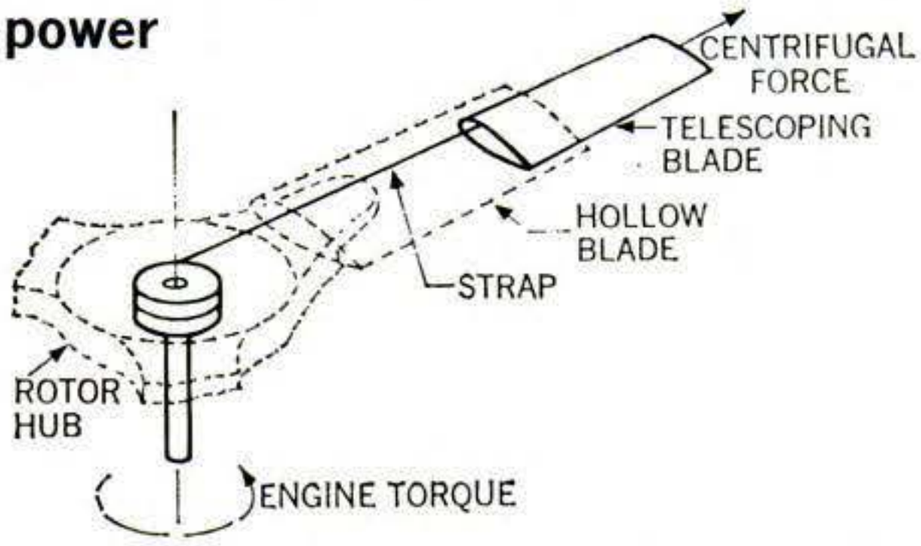
Going to work—720 feet down

Said to be the deepest-diving unit for commercial use, Dräger's diving chamber can hold four men. A helium-oxygen mixture is pumped down under pressure, but the chamber also carries its own emergency supply. Divers exit for work through a bottom hatch. Winched to the surface, the chamber links to a decompression chamber.



Telescoping copter blades vary diameter to save power

These copter blades developed by Bell extend to 25-foot diameter for takeoff, to give maximum lift, telescope to 15 feet in flight for maximum engine efficiency. Blade length is governed by balancing engine torque against centrifugal force; when needed engine torque exceeds the centrifugal force, the blades retract to achieve balance. The drive shaft turns blades by applying tension to straps holding outer sections—the hub is freewheeling.



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The Best Tape System

REEL, CASSETTE, OR

Deciding on a system? First bone up on the five ways recorders and players use magnetic tapes

By **SAM SHATAVSKY** / *PS Electronics Editor*

Choosing a tape machine these days can be a confusing and complicated business. With the magnetic-tape industry offering you five different systems, in a pitched battle for your tape dollars, you'll be hard put to make up your mind. If you don't choose carefully, you may spend your money on a tape system that's not for you or, what is worse, one that could become obsolete (there is one now that is losing ground).

The greatest push is in cassette and eight-track cartridge machines, with less emphasis on reel-to-reel, four-track, and Playtape. These are the five tape systems in use today. That a fog of confusion swirls around them is an understatement. They aren't compatible, packages are not alike, and tape dimensions, speeds, and number of tracks differ from one to the other.

To clear up the confusion, I went to the major tape companies—Ampex, Norelco, Motorola, Playtape, RCA, Wollensak

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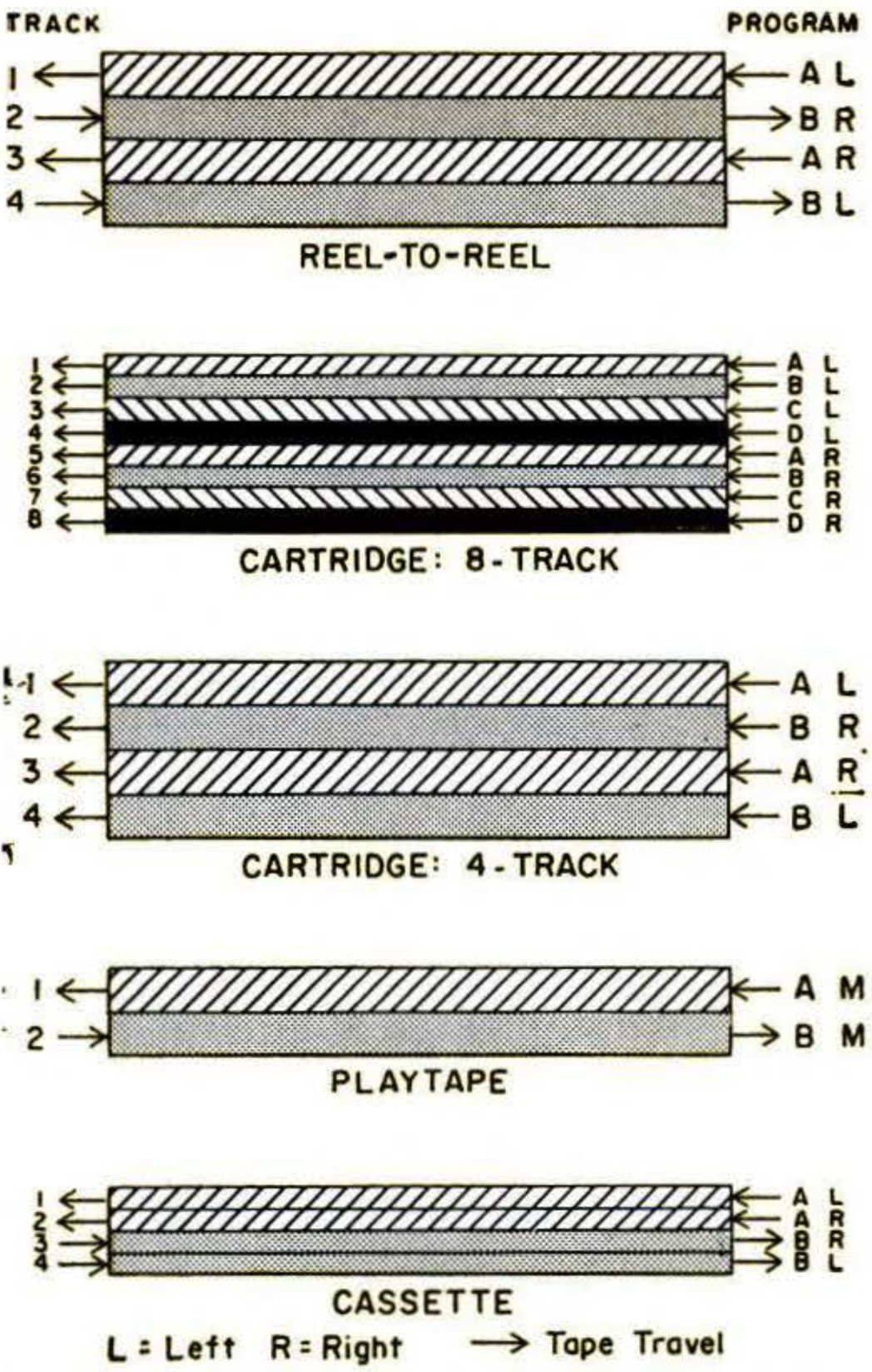

Recorded tracks on tape vary from system to system, ranging in number from two to eight. Program tracks are designated as A, B, C, or D. Pairs (two A's, etc.) indicate stereo. Playing time depends on number of tracks, as well as on tape length and speed.

Reel-to-reel machines, running at highest tape speed, give highest fidelity. Although most require starting tape by hand, some have automatic threading. Above is Wollensak (3M) model 6100.

Cassette system, originally developed by Norelco for portable voice recording, has expanded to music recording and playback as well. Portable voice recorder shown here is Norelco's 150 Carry-Corder.

for You:

CARTRIDGE?

(3M)—to get the facts, good and bad. What I learned I'm passing on to you in this rundown of the five tape-handling methods.

Reel-to-reel system. This is the oldest system around. Introduced about 20 years ago, reel machines are available as complete record-playback machines including a speaker output, or as tape decks to go with hi-fi systems. Present practice puts four tracks on the tape, in two stereo pairs. The reel is flipped over to go from one pair to the next. Reels have two big drawbacks: They must be threaded into the machine and they take much more storage space than the other systems—they're six times larger than a cassette,

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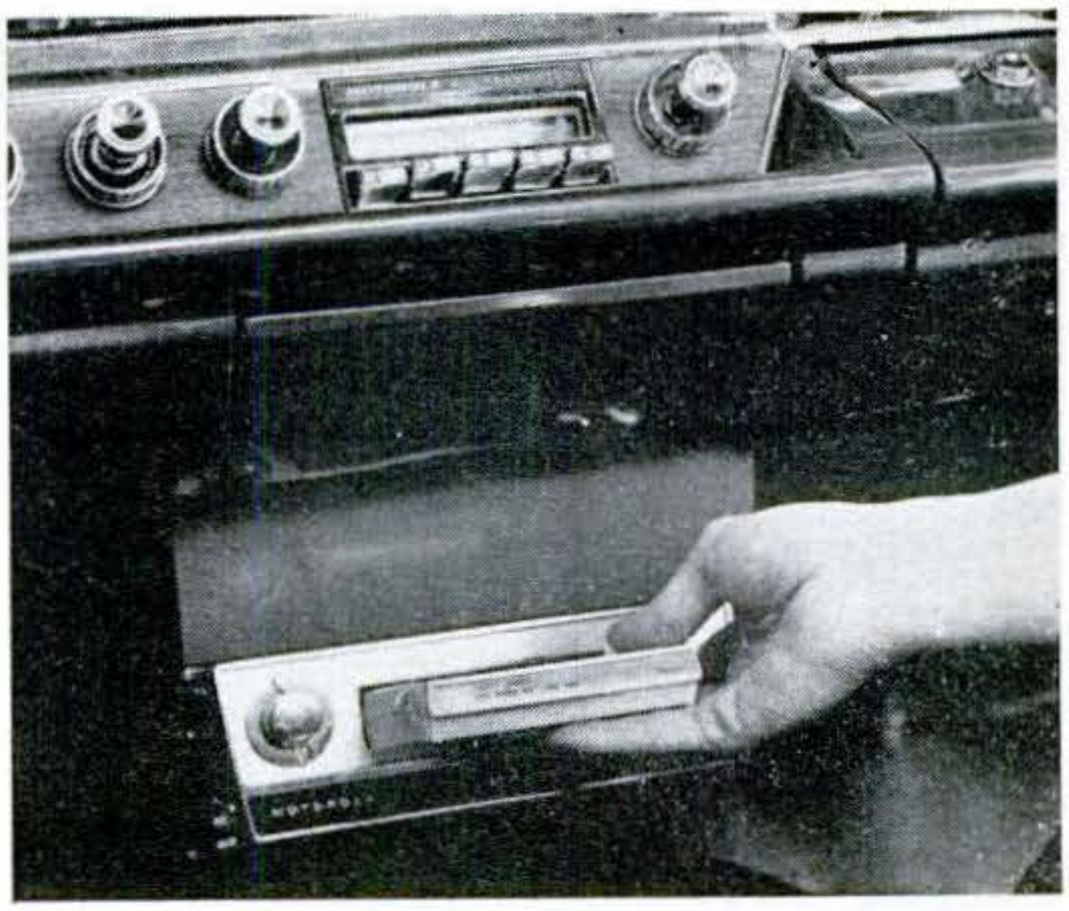

Tape cartridge, ideal for automobile music players, is the most popular of all tape systems. Starting as Lear, RCA, and Motorola venture, eight-track has also proved its worth in home players.

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THE TAPE SYSTEMS: WHAT THEY CAN DO

	REEL-TO-REEL	CASSETTE	8-TRACK	4-TRACK	PLAYTAPE
STEREO/MONO?	Stereo/Mono	Stereo	Stereo	Stereo	Mono
NO. OF TRACKS	4	4	8	4	2
TAPE WIDTH	1/4"	1/8"[a]	1/4"	1/4"	1/8"
TAPE SPEED (in. per sec.)	7 1/2, 3 3/4, 1 7/8	1 7/8	3 3/4	3 3/4	3 3/4
PLAYING TIME (max.)	6 hr.[b]	2 hr.	1 hr., 20 min.	40 min.	24 min.
DIMENSIONS	7" diameter[c]	4" x 2 1/2" x 7/16"	5 1/2" x 3 3/4" x 3/4"	5" x 3 3/4" x 3/4"	3 1/4" x 2 3/4" x 3/8"
RESPONSE, Hz (typical)	40-15,000	60-10,000	50-12,000	50-12,000	50-8,000
FUNCTIONS	Record & play back	Record & play back	Play back	Play back	Play back
BEST, if you want:	Highest fidelity, longest playing time	Record and play ability in smallest size	Automobile player, easiest operation, good fidelity	Not recommended; becoming obsolescent	Portable pop music on-the-go, children's player

Notes: All machines are good for home, auto, portable use, except reel-to-reel (not auto)
[a] Actual dimension .150 inches
[b] At 1 7/8 inches per second, 3,600-foot tape length
[c] Smaller reels also available

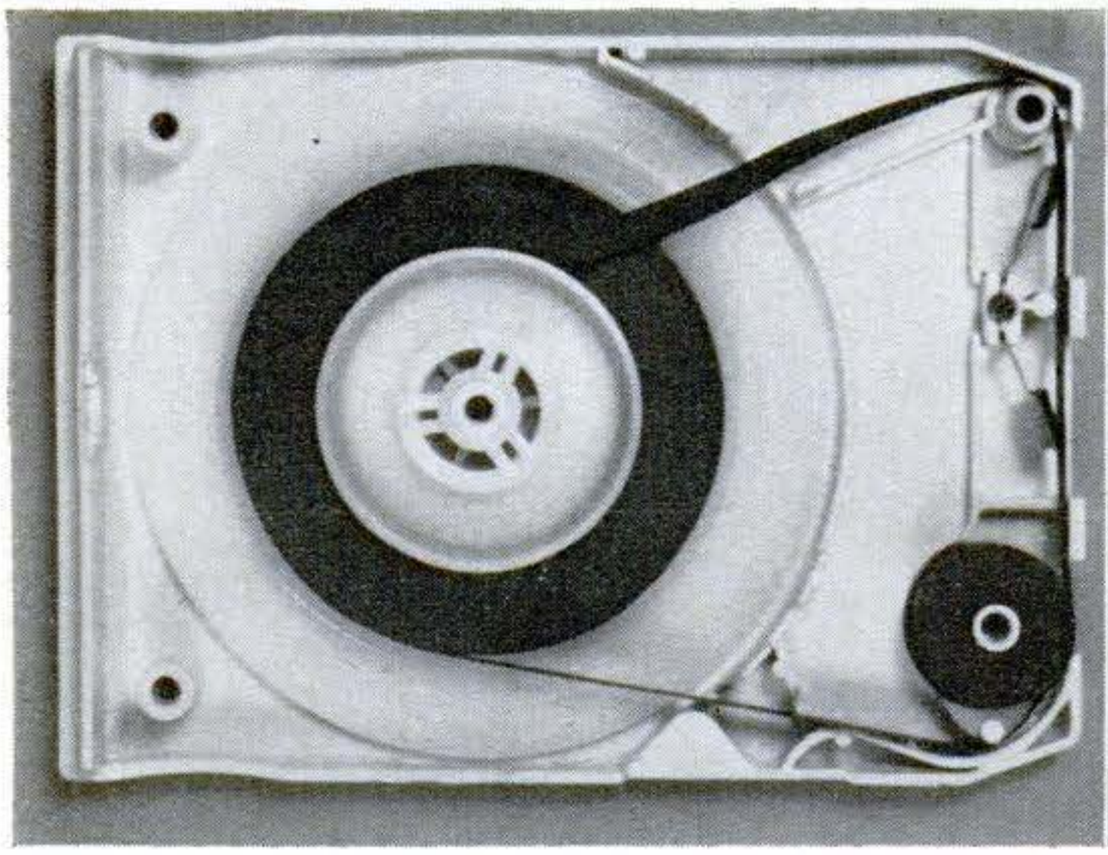
twice as large as a cartridge. Prerecorded music tapes have slacked off in popularity with the introduction of the cassette and cartridge.

Cassette system. Made up of two tiny reels in a sealed plastic container, the cassette operates like its granddaddy, the reel machine. But there's no threading: You simply insert the sealed cassette into the machine and run it. Originated by Norelco, the cassette machine was introduced as a portable voice recorder five years ago. It has since graduated to the music level, with recording companies digging into their libraries to put selections on cassette. And, of course, cassette owners can themselves record from radio and records. Sound quality equals that of a good AM radio.

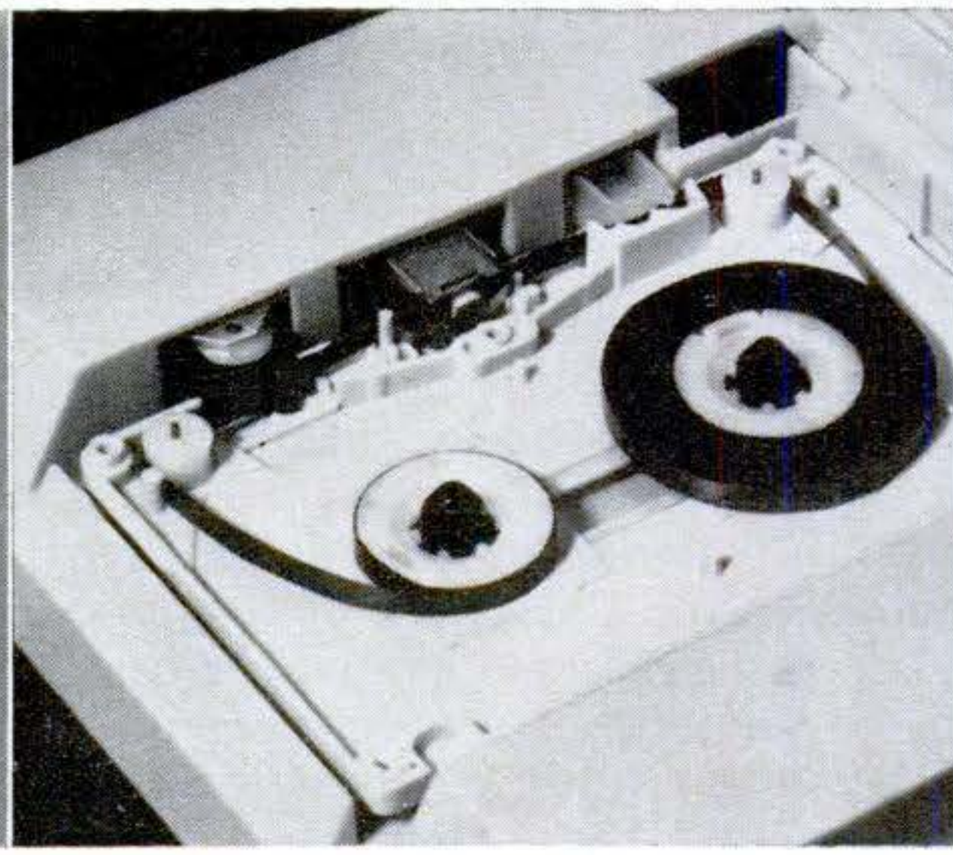
Cartridge system. There are three kinds —eight-track, four-track, and Playtape— each using a single tape reel in a closed plastic container. The continuous loop of tape feeds from the reel's inner edge, past the magnetic pickup head, and back to the outside of the reel. To play it, you simply insert the cartridge into a slot in the player.

- *Eight-track,* by far the most popular cartridge today, was pioneered by Lear, RCA, and Motorola. Originally conceived to bring personal-choice music into automobiles, it has moved into the home as well, and offers the largest music library of all the tape systems. It will give you up to 80 minutes of continuous playing time with sound quality to match that of an LP record.

Magnetic recording: How it works



Eight-track stereo cartridge, opened, looks like this. Reel feeds single endless-loop tape from the hub.



In playing position, cassette's tiny reels that feed tape past magnetic playback head are seen at rear.

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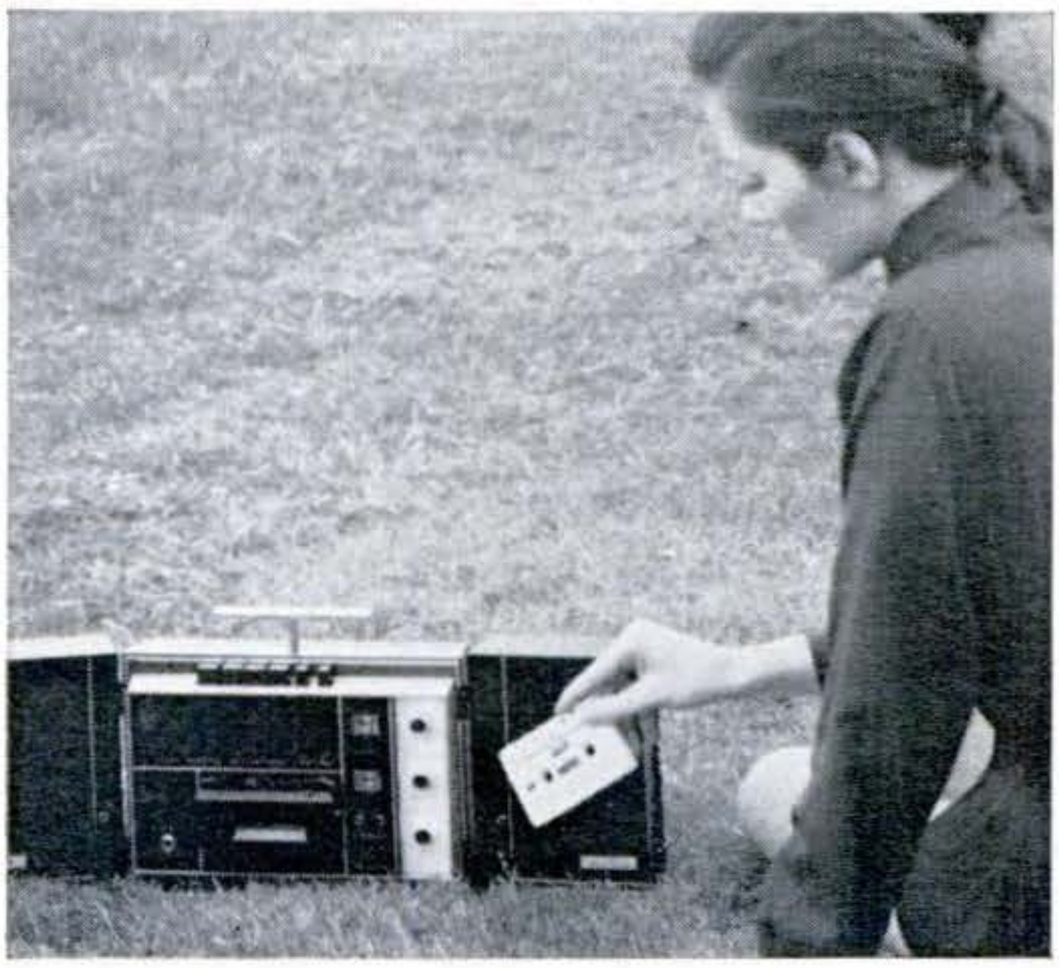
Cassette tape deck for hi-fi systems records and plays stereo. Fast wind/rewind locates any song or movement for replay. Pictured is Ampex Micro 50.

Low-cost Playtape system was designed to play pop music and children's recordings. Language lessons are being added. This is Playtape's model 1110.



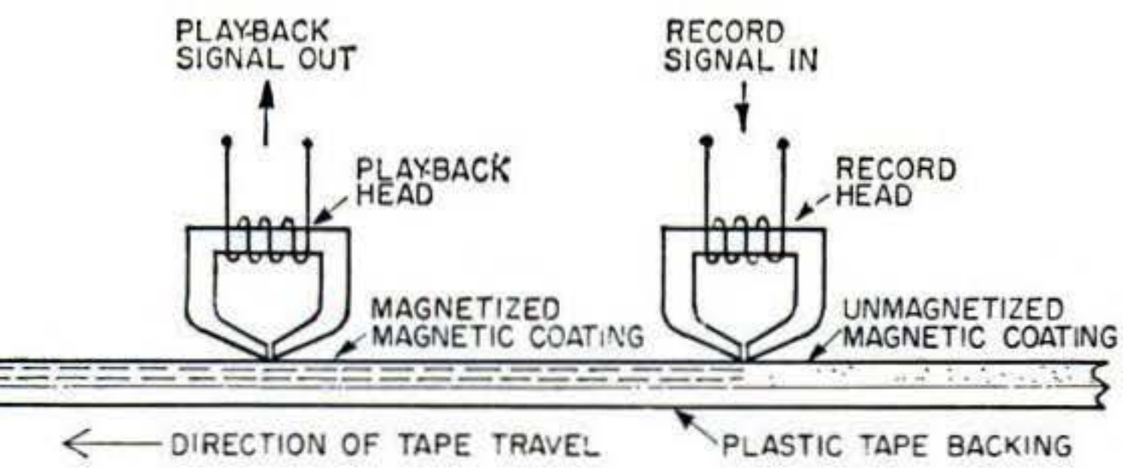
Outdoor tape machines for music-on-the-go are gaining popularity. Cassette stereo recorder-player shown here is Emerson's model 32M01.

• *Four-track* was also designed for automobile listening, but suffers from limitations—mainly, half the playing time and fewer automatic features than eight-track. Although still popular in some areas—the West Coast, for example—the four-track cartridge system appears to be losing ground generally.

• *Playtape cartridge*, a playback music source for small portable machines, is mainly for teen-agers interested in having rock-music-on-the-go and for playing children's recordings. Machines cost little. Fidelity is limited by speaker size but is generally adequate for the undemanding uses mentioned.

And that's the picture of the systems as they stand today. Four-track should be avoided. Your choice among the other four depends on what you're looking for —high fidelity, convenience in use, recording capability, compactness. These will determine the tape system best suited to fill your need for recording and playing back voice and music. PS

A magnetic tape system can be compared to a record player. The magnetic record head writes and the playback head reads magnetic tracks on tape just as a cutting stylus records and a cartridge needle picks up signal grooves in a phonograph record. On tape, recording is accomplished by arranging magnetic oxide particles on the tape in a magnetic pattern.



The magnetic playback head senses the recorded pattern to generate signal voltage, which is amplified for speaker output. With all other factors equal (same heads, same tape), frequency response depends on tape speed. The faster the tape runs past the head, the better will be the frequency response. This explains why a reel-to-reel machine running at 7½ inches per second gives better frequency performance than a cassette machine operating at 1⅞ i.p.s. Eight-track cartridge tape, with 3¾-i.p.s. speed, is a happy compromise for good frequency response with reasonably long recording time.

Hopes of higher response at slower speeds lie in improved magnetic coatings and greater resolving power of heads. Recording engineers are working toward a breakthrough, now.

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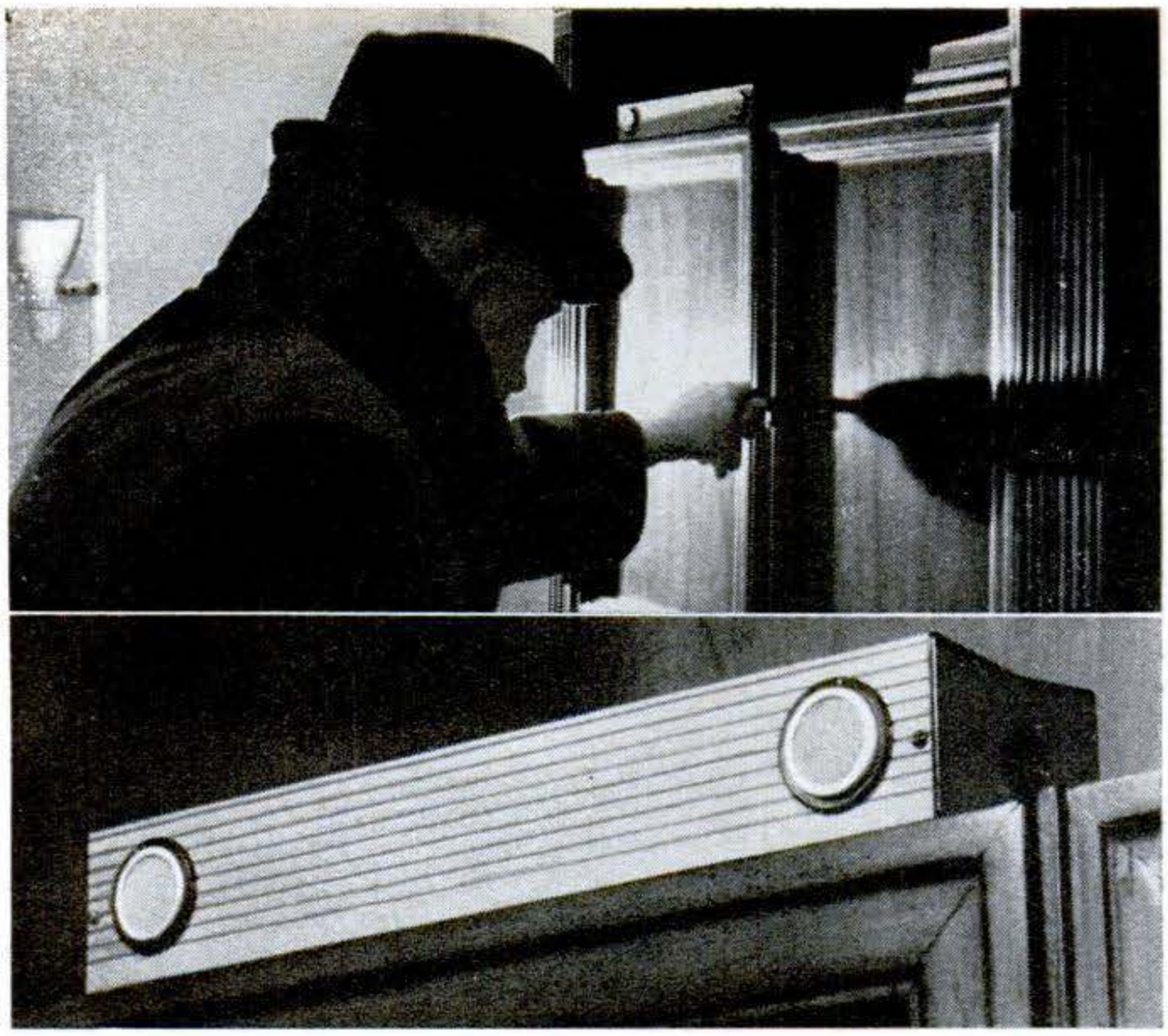
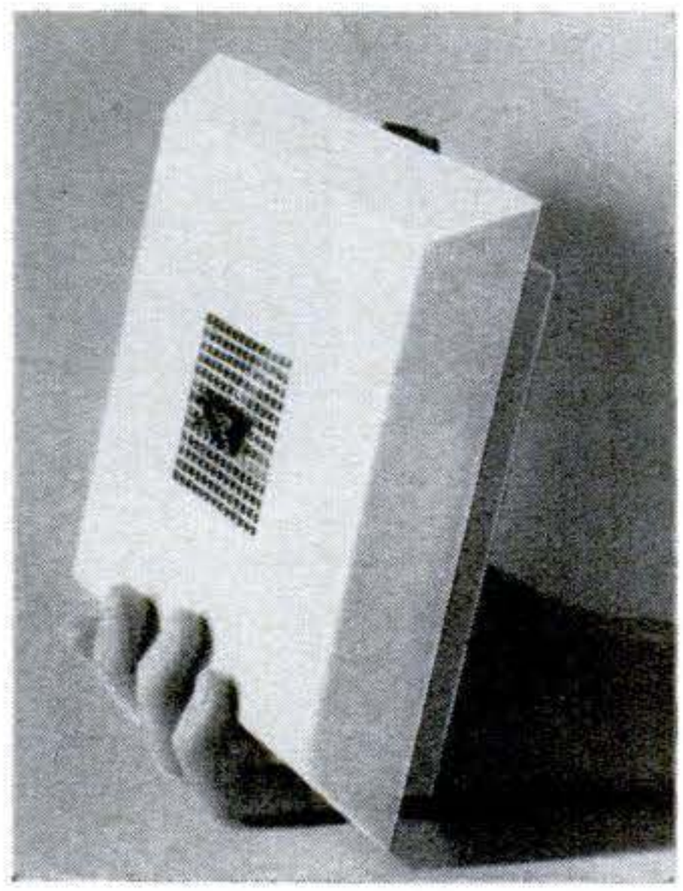


Intrusion alarm works on ultrasonic principle

This burglar alarm sets up ultrasonic waves in the room or area being protected. Radar-like in operation, it is triggered when an intruder enters. You plug it into any outlet; no special wiring is needed. Two triggered outputs for lights and a bell operate with 20-second delay between them. Model A-1, 115 volts AC, $97.50; Model MA-2, 12 volts DC, $99.50. Euphonics Corp., Miami Springs, Fla.

This portable radio floats and plays in water

Designed to provide listening entertainment for bathers, this AM radio works in pools and freshwater lakes, even your bathtub (but not in salt water). Shaped like a buoy, it has top-mounted controls for easy tuning. The RCA Floater is battery-powered and sells for about $20.



Home fire alarm detects smoke and odorless gases

Completely self-contained and battery-powered, this electronic detector senses odorless, colorless combustion gases as well as smoke and flame. The Electronic Smoke Sniffer's 110-decibel alarm is loud enough to wake sleepers in any part of a house. $85 from Warren Enterprises, Skokie, Ill.

Marine sound center for voice projection and audio pickup

In addition to broadcasting and receiving sound, this high-power marine audio system has manual and automatic foghorn, intercom, and alarm to warn against fires, bilge leaks, and break-in. It operates on 12 volts DC and comes complete with speaker and microphone. $130. Simpson Electronics, 2295 N.W. 14 St., Miami, Fla. 33125.

TO REMOVE SECTION for loose-leaf binding, open magazine wide at this page, rest it on table, run your thumb firmly along center fold. Then pull out the sheets gently, one at a time.

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PS EXTRA! 16-PAGE SPECIAL REPORT

Secrets of Keeping Your Automatic Washer Trouble-Free

Follow two sound rules and you can become master of routine repairs. Before you begin:

1 Be sure of your diagnosis—never take the machine apart, hoping that you'll stumble on the trouble.

2 Plan ahead for all steps of the job, both disassembly and reassembly.

By EVAN POWELL

Ease of service is a major point to consider in buying an automatic washer. Removable front panel and hinged top permit front servicing of this Maytag without moving the appliance from against the wall.

Take time first to understand how your automatic washer works. After that, most repairs are usually just a matter of using common sense

Automatic washers operate from electrical commands given by manually or automatically operated switches. The commands are carried out by solenoids and motors.

To enable you to understand how these actions take place in an automatic washer, we present this series of schematic drawings. They show the actions that occur when the master control, in this case the timer, gives various commands.

As an aid to understanding, we have removed the timer from the machine and set each of its cams to the side. This lets you see the action of each switch in the succeeding phases of the cycle that the washer passes through.

In actual practice, of course, these cams and switches are combined into one unit, and there may be 30 to 50 contacts in some of the more complex controls.

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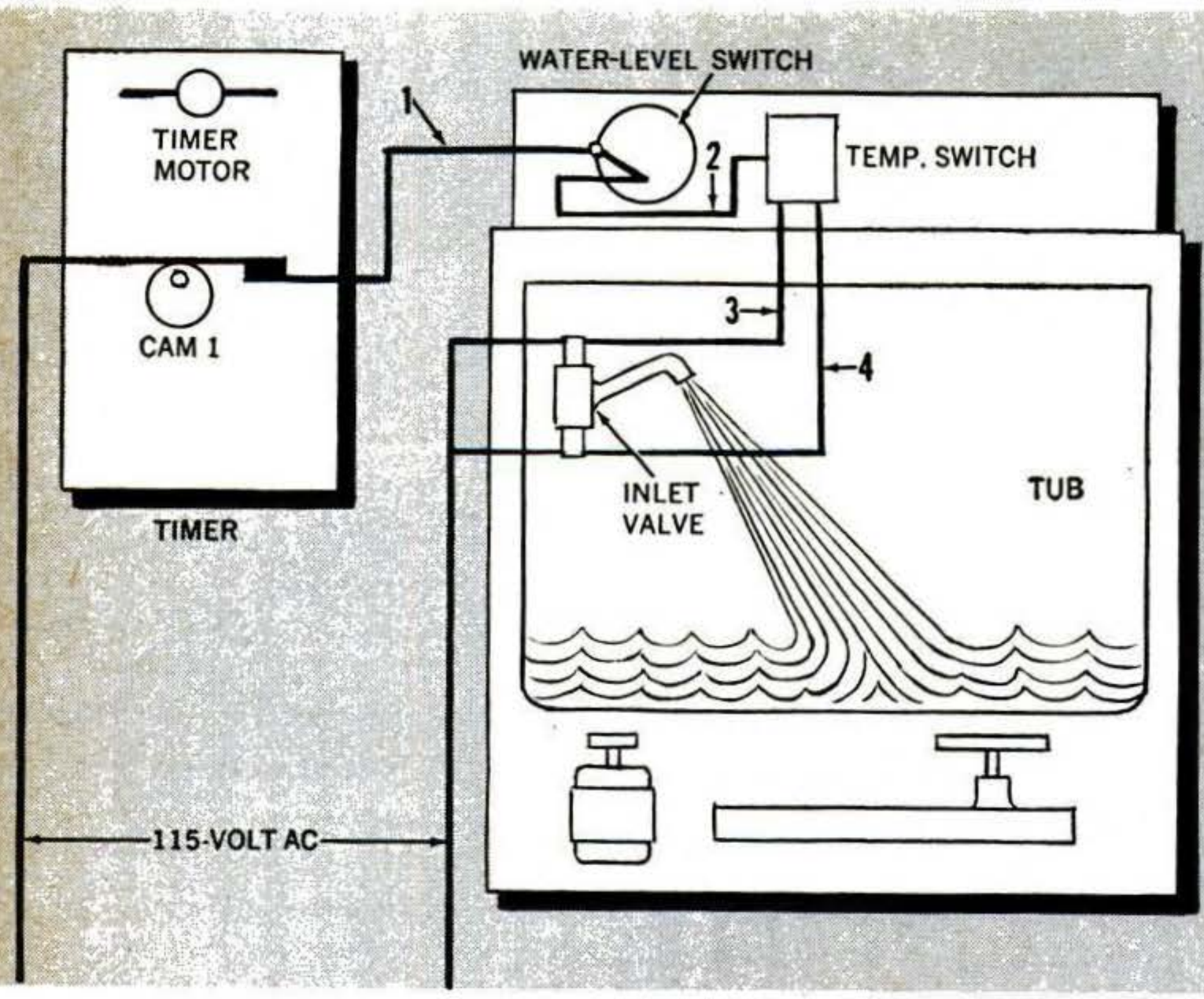
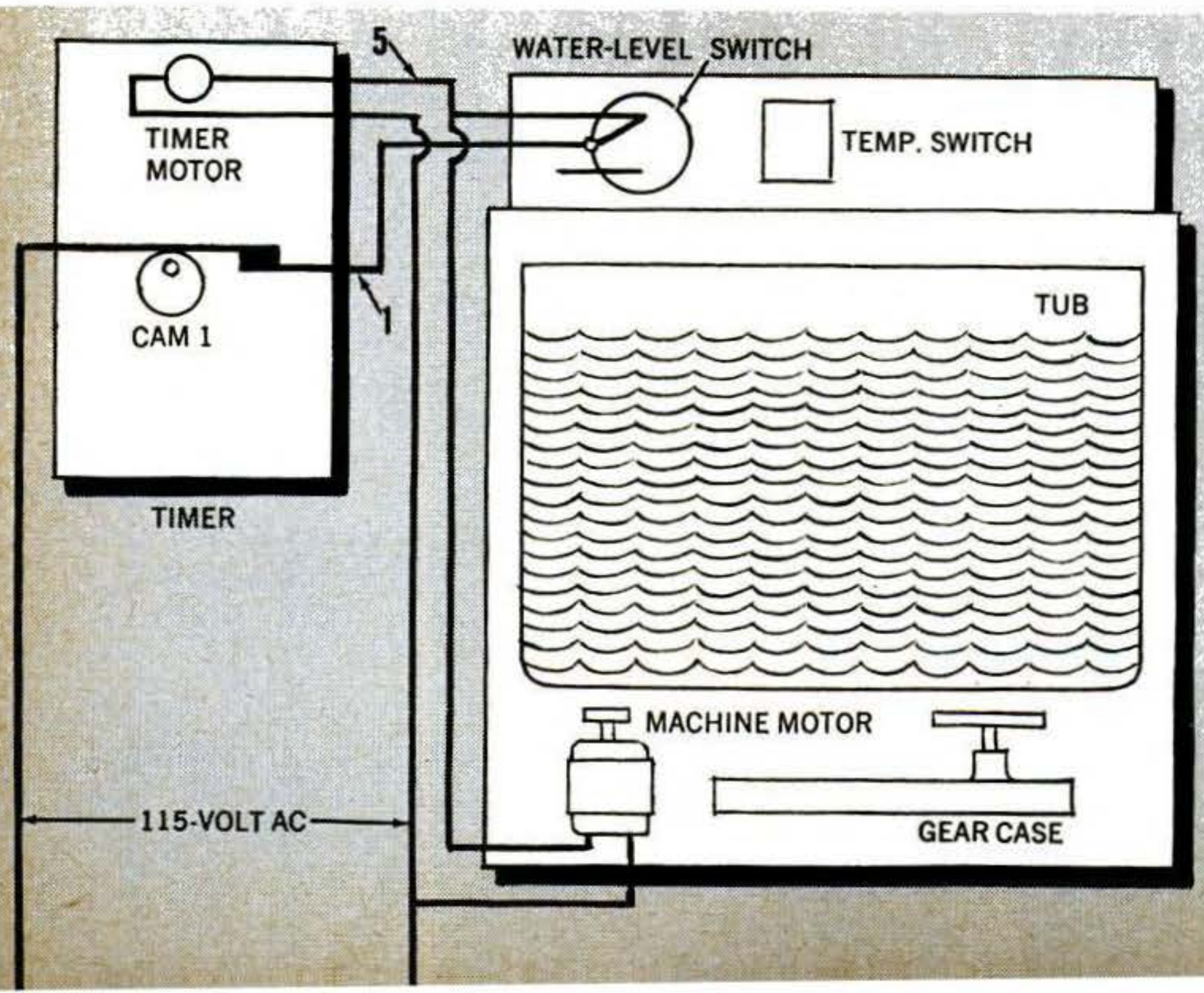
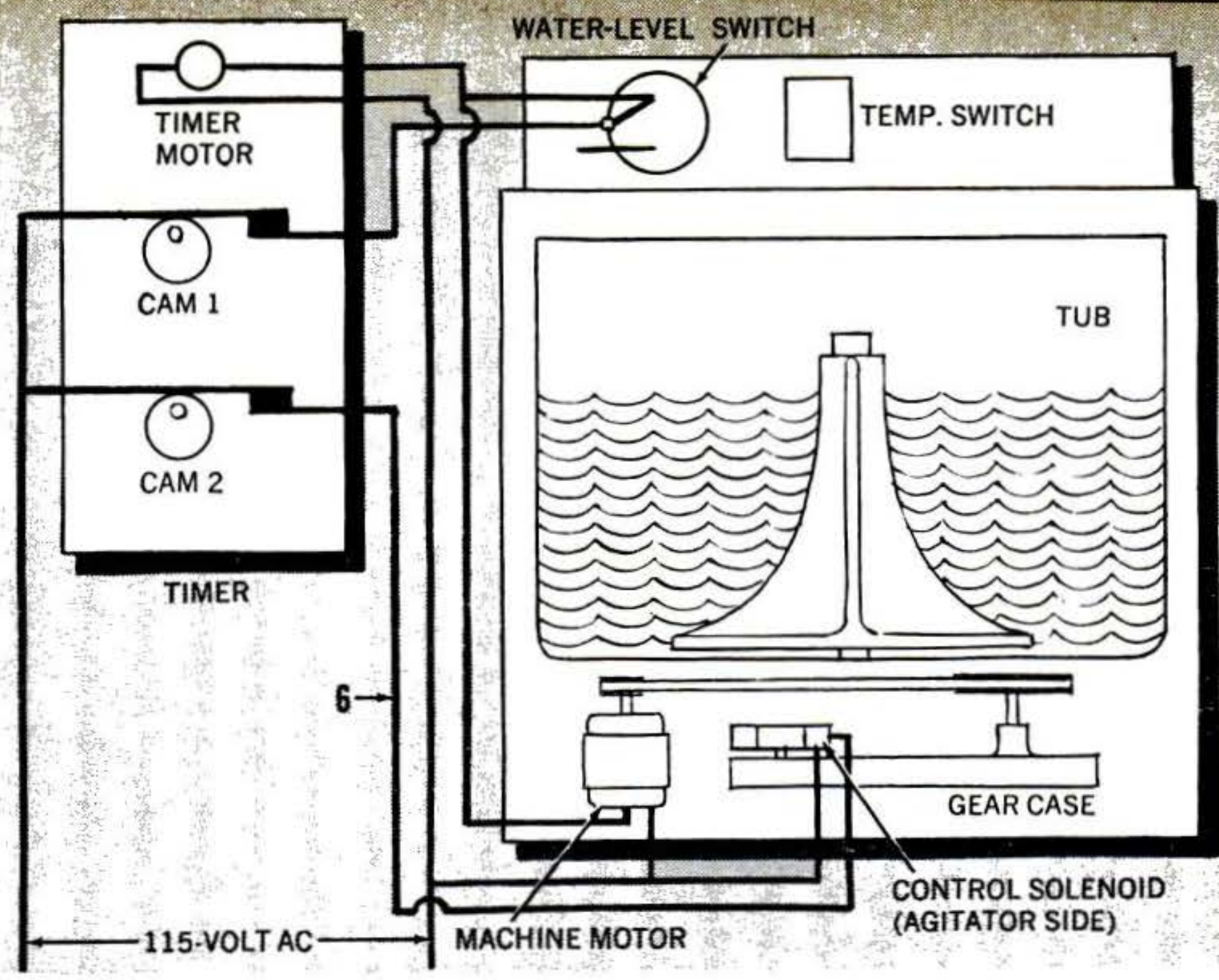


1 **Fill cycle.** By closing a contact that applies voltage to the float or water-level switch, the timer commands the machine, through wire No. 1, to fill. Since the machine is empty, the float switch does not over-ride the command but transfers it to the temperature switch through wire No. 2. The temperature switch, previously told by the user what temperature to select, then transfers the command to the inlet-valve solenoids through wire No. 3 for cold water, wire No. 4 for hot water, or both for warm water. The solenoid, an electromagnetic device, then in effect "opens the faucet" by raising a plunger inside the valve, allowing water to flow into the machine. Notice that no circuit is completed to the timer motor at this point, and the cams controlling the switches won't be advanced before the machine is full.

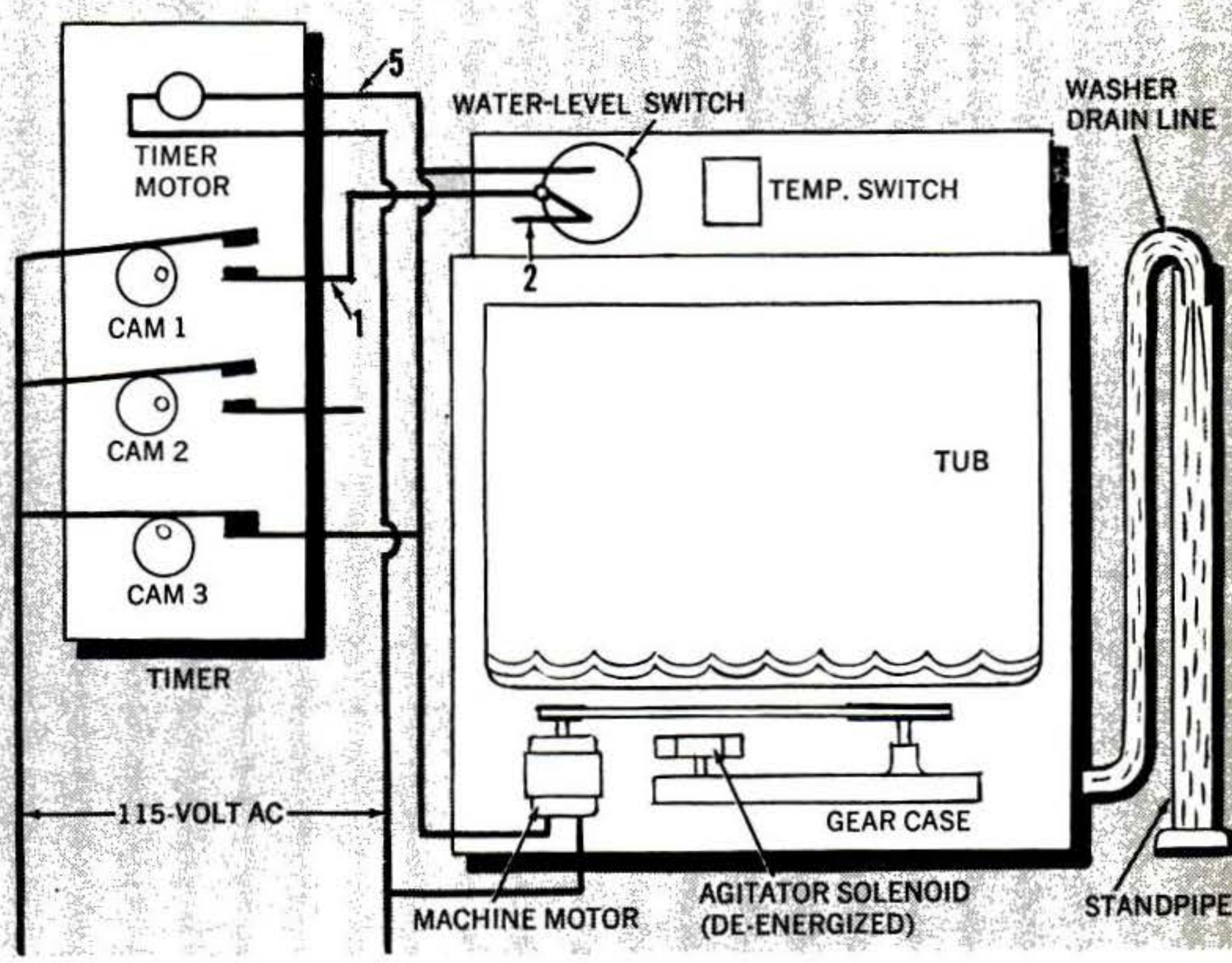


2 **Fill cycle continued.** As the water in tub approaches the correct level, air or water pressure builds up and acts on the diaphragm of the float switch. The timer still gives its command through wire No. 1, but the movement of the diaphragm has shifted the switch to wire No. 2, releasing the temperature switch and the inlet switch from the command. Instead, the command is transferred to the timer motor and the machine motor, causing the cams within the timer to advance approximately six degrees every two minutes, and causing the machine to start running.

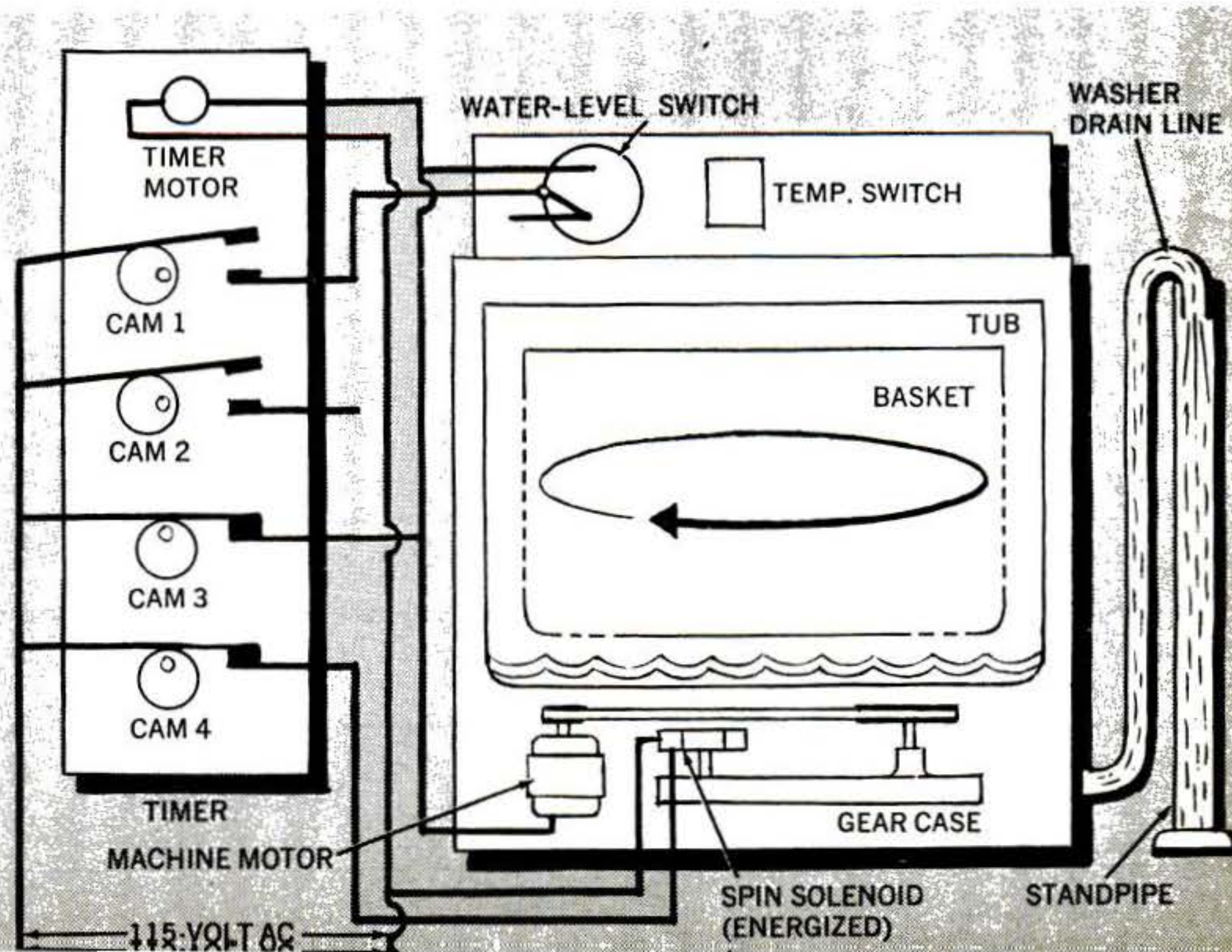
3 **Agitation.** As the machine begins to run, another cam is brought into action. It gives a command to another solenoid device through wire No. 6. This solenoid in effect puts the machine into gear, and the agitator moves back and forth in the water. In a tumble-type or front-loader, this cam would control a switch that would select the correct speed for basket movement, allowing the clothes to tumble in the water.



4 **Pump-out.** To pump the water from the machine in order to bring in fresh water for a rinse or to prepare for the final spin-dry, cam 2 has raised its movable contact, breaking the command to the agitate solenoid. This puts the agitator out of "gear" again, and at the same time moves the pump valve into the open position, allowing the pump to force the water out the drain line and into the standpipe in the house drainage system. Now, another provision must be made here, for as the water level in the machine drops, circuit No. 1, to the float switch, will again transfer from circuit No. 5 to circuit No. 2, the machine and timer motors will stop, and the machine will begin to fill again. To prevent this from happening, the cam controlling wire No. 1 has moved this contact to break the circuit and another contact (cam 3) is added to keep circuit No. 5 energized. Thus, a "bypass" circuit is established and the motors can operate the machine.



5 **Spin-dry.** The bypass circuit remains in action, and cam No. 4 now closes a timer contact commanding yet another solenoid device to move a mechanical linkage that operates a clutch, allowing the basket to rotate at high speed. The pump also remains in action, as centrifugal force causes the water to leave clothes; water must also be removed from the machine. After the spin operation continues for a predetermined time, all cams open their respective contacts and machine operation ceases.



PS Extra: WASHER REPAIR

Your Quick-Check Chart for Automatic Washing Machines

Symptom	Cause	Remedy
No water enters machine	Hose crimped; faucet off Filter screens clogged Inlet-valve solenoid open Water-level switch open	Correct as needed Clean or replace Replace Replace
Water will not shut off—machine overflows	Foreign particles in inlet valve Inlet-valve solenoid grounded Tube to water-level switch blocked Water-level switch faulty	Disassemble and flush with water Replace solenoid Clear tube of obstruction Replace switch
Machine will not run	Blown fuse Faulty power cord or plug Motor faulty Belt loose or broken	Replace Replace with heavy-duty cord Repair or replace Adjust or replace
Machine will not agitate	Agitate solenoid inoperative Loose drive pulley(s) Faulty transmission drive	Replace coil or repair linkages Tighten setscrews Refer to servicing organization
Timer will not advance	Binding Timer motor open Timer escapement inoperative	Lubricate carefully Replace motor Replace timer assembly
Lint filter inoperative	Tub outlet blocked Pump or pump valve inoperative Lint-holding fabrics being washed with lint-giving fabrics	Remove restriction—check washer loading Disassemble pump and repair or remove foreign object from pump Observe special loading procedure
Water leaks	Hose connections faulty or hose deteriorated Drainage pipe clogged Tub or pump housing pitted	Tighten or replace Clean drainage system Replace
Water will not pump out	Tub outlet blocked Pump or pump valve inoperative Pump coupling or belt broken	Remove restriction—check washer loading Disassemble pump and repair or remove foreign object from pump Replace
Machine will not spin-dry	Solenoid inoperative Water or detergent in outer tub Lid safety switch inoperative Clothing around basket hub Slipping belt Slipping clutch	Replace solenoid or repair linkages See "water will not pump out"; observe oversudsing precautions Replace or adjust linkages or brackets Remove and check loading procedure Check for proper tension Adjust or replace lining as necessary
Excessive vibration	Load out of balance Machine not level or solid on floor	Rearrange clothing in basket Adjust leveling feet to correct height; see that rubber boots are in place
Unusual noise	Assorted mechanical noises Sticking friction pads Springs squeaking Belt squealing	Use makeshift "stethoscope" Clean surface to remove glaze Coat with light layer of grease Adjust to proper tension

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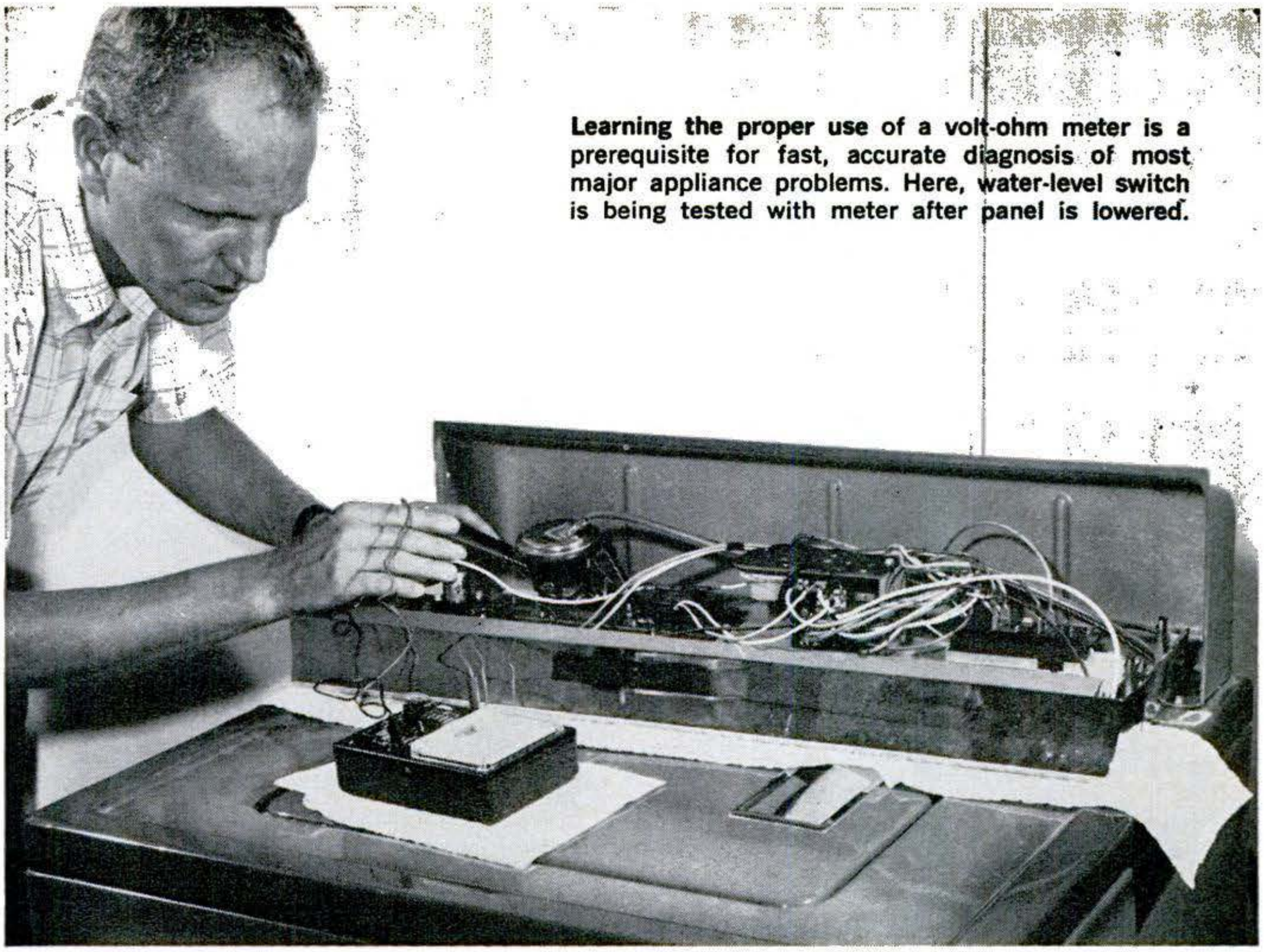

Learning the proper use of a volt-ohm meter is a prerequisite for fast, accurate diagnosis of most major appliance problems. Here, water-level switch is being tested with meter after panel is lowered.

Common Troubles of Automatic Washers and How to Cure Them

Let's suppose you have just returned from a summer vacation. You're looking forward to a final lazy afternoon before returning to work. As you settle down, a cry of dismay comes from the utility room where the soiled vacation laundry is piled up. The automatic washer won't work.

As you approach this modern marvel, you notice that it has filled with water. But instead of a happy splashing sound, only a faint hum is heard.

If you knew a little of what a service technician knows, you could probably spend 10 minutes with a screwdriver and 9/16-inch wrench tightening the belt, saving the day and a fat repair bill.

Service technicians spend most of their time answering calls for such simple repairs or adjustments. Only a small percentage of calls involve difficult technical problems. So *you* can repair your machine more often than not.

Continued

The tools you'll need

- Screwdrivers
- Pliers
- Set of wrenches
- Soldering gun
- Hose-clamp pliers
- Volt-ohm meter

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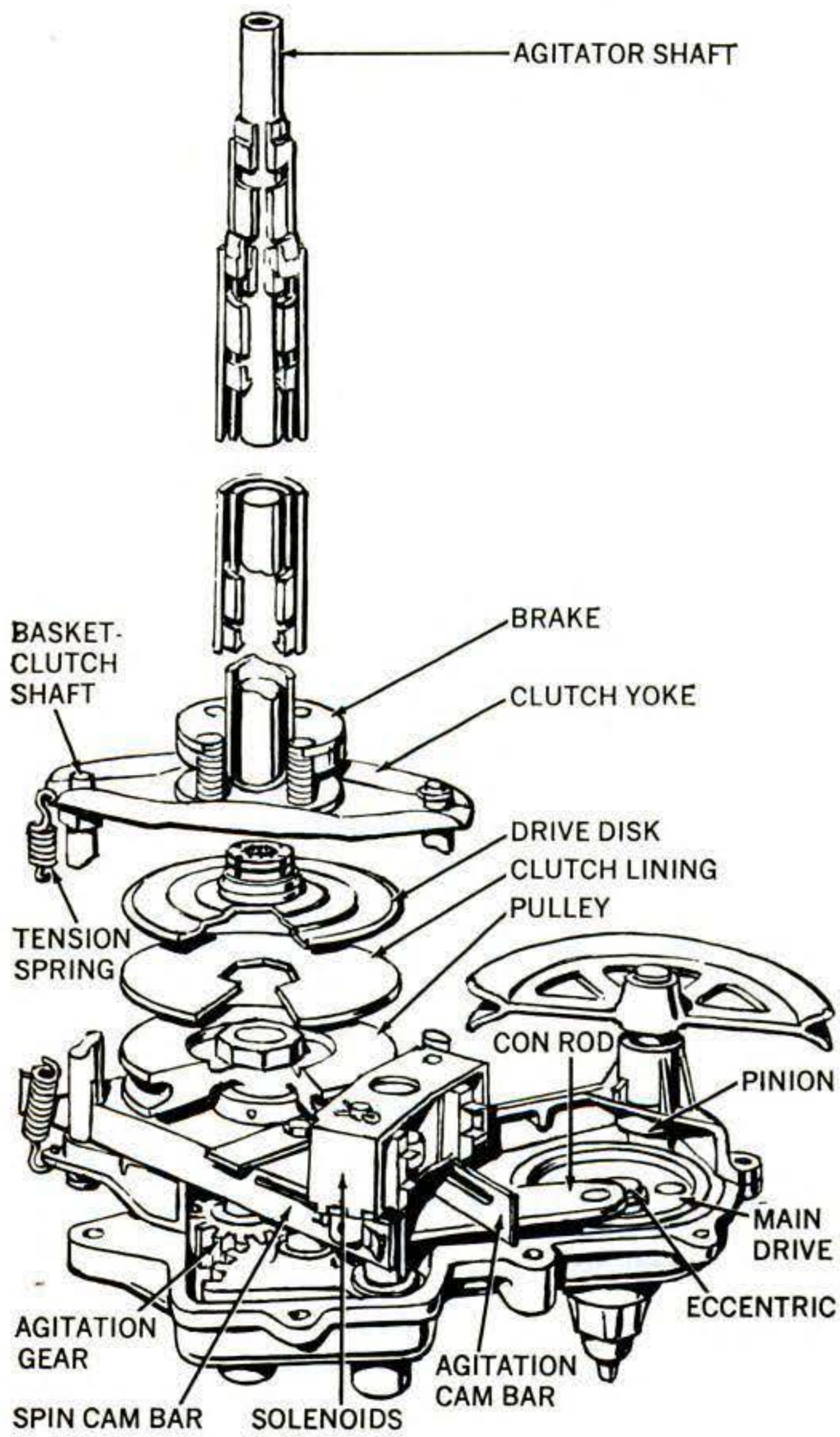
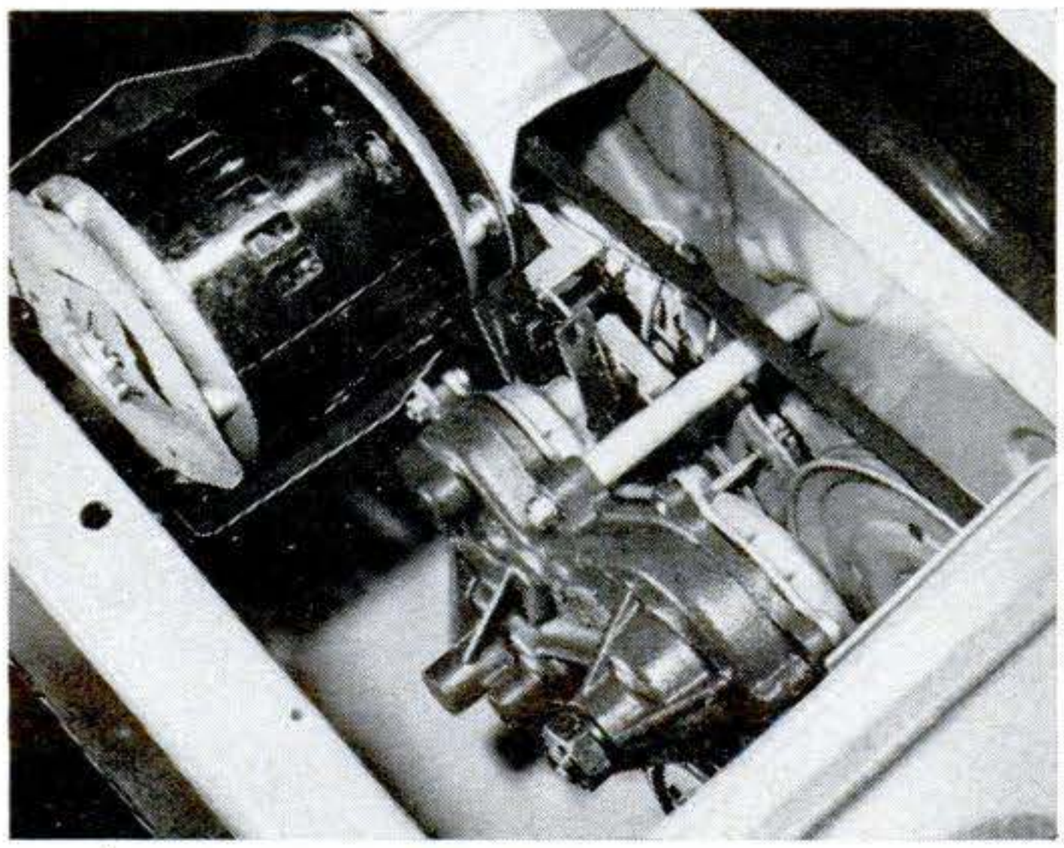
PS Extra: WASHER REPAIR



Cutaway view of Whirlpool drive assembly shows how agitator is driven through gear train at bottom of unit, while spinning and braking action of basket is done through clutch assembly above. Tension spring must be removed and basket-clutch shaft freed from cam bar to change belt. Photo below shows assembly as viewed through service panel.



No doubt, you have heard of a "basket job"—where the service technician must assemble a box of parts before he can check for the trouble. This is a product of poor planning.

To prevent your project from becoming a basket job, keep these points in mind:

- First, look ahead to the completed job before you begin work. Look at each component involved and plan each step you will take in disassembly and reassembly.
- Second, be sure of your diagnosis before you begin to dismantle the machine. Never take the machine apart with the hope of stumbling on the trouble.

Following these two rules will enable you to restore your machine to service a good part of the time. But you should also make it a rule to avoid two classes of repairs—dismantling the transmission (or replacing the transmission bearings) and repairs inside electronic controls or timers. Work in these areas requires highly specialized equipment and knowledge.

The tools you need. For most appliance-repair work, a set of common and Phillips screwdrivers, pliers, a set of wrenches, and a soldering gun will be sufficient. A set of ⅜- or ½-inch drive sockets with a ratchet makes many jobs easier.

Two tools I'd also recommend are hose-clamp pliers, costing between two and three dollars (and also useful for automobile repairs); and a volt-ohm meter (rather than a test lamp) for checking voltage and continuity. Some small imported volt-ohm meters cost as little as $3.98. These little instruments are not intended to be extremely accurate, but they are sufficient for most home jobs.

Automatic washers vary in appearance and design, but they all wash, rinse, and spin-dry the clothes in much the same way. Top-loading washers are by far the most popular. Clothes are loaded through an opening or lid in the top of the machine into an upright basket. The basket fills with water, and a gear case or eccentric drive moves a vaned agitator or pulsator back and forth or up and down in the water. All washers clean clothing primarily by forcing water and detergent through the fabric, not just by contact with the fabric. Rinsing is provided by flooding fresh water through the washed clothing.

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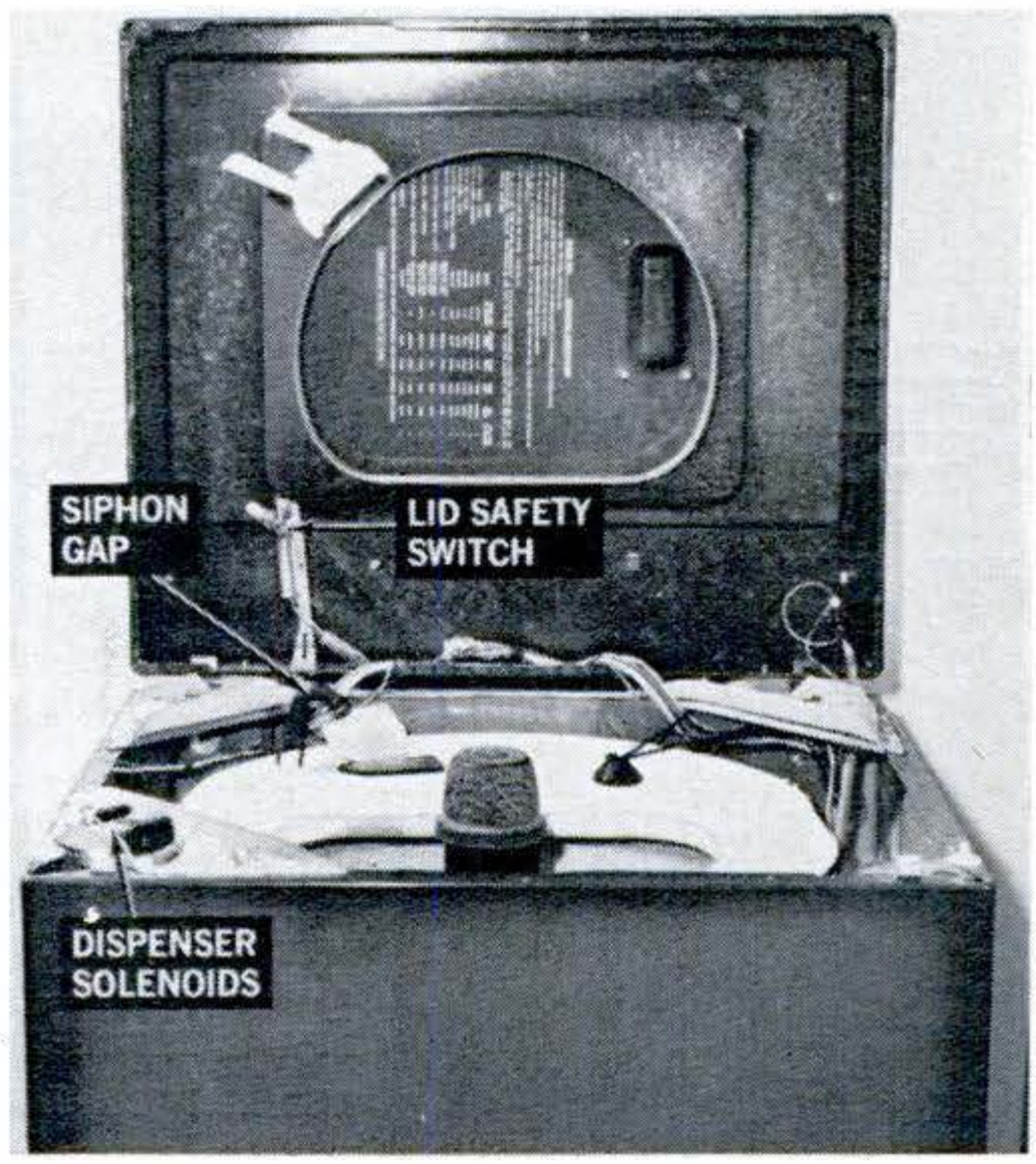
In the top loader, clothing is dried by spinning the basket and letting centrifugal force pull water from the cloth. Some top loaders drain water through perforations in the basket into an outer tub, from which it is pumped out before the basket begins to spin. Other models begin to spin the basket while it is still filled with water. As centrifugal force mounts, water flows to the top of the basket and out into a tub formed, in many cases, by the outer cabinet itself. From here it is pumped out of the machine through the drain line and the trap installed at the rear by the wall.

In top loaders, the drive mechanism, motor, and pump are suspended under the tub, and are accessible through panels either at the front or rear of the machine.

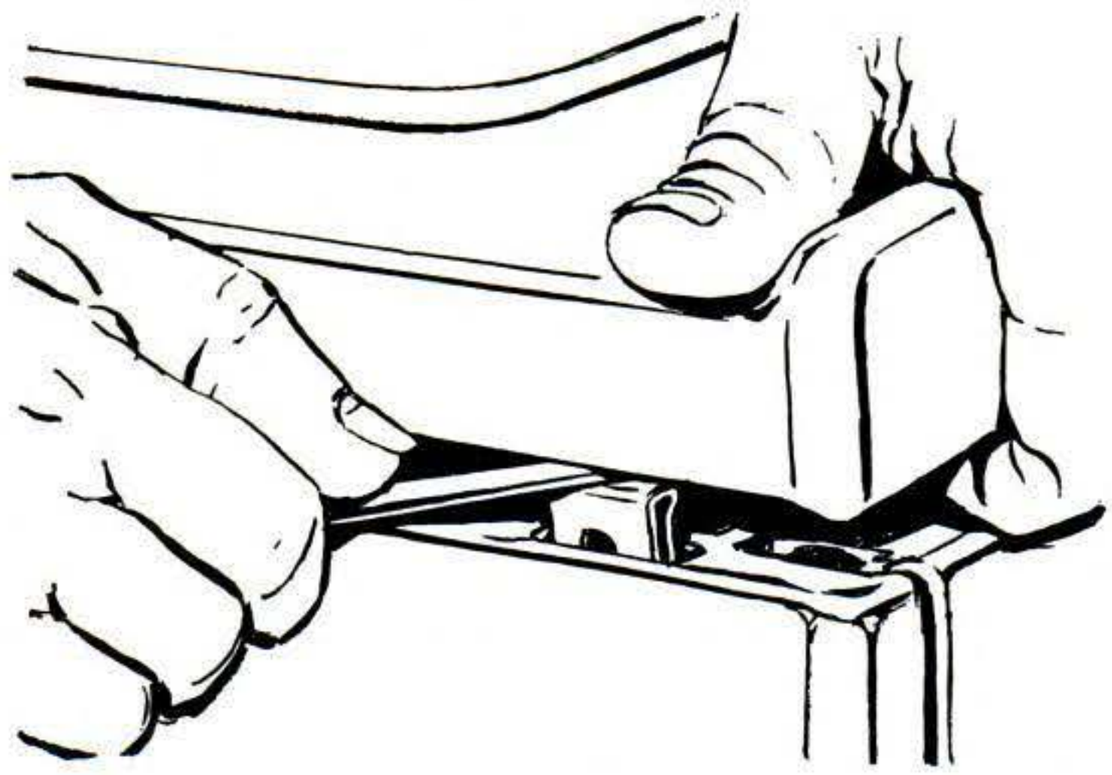
On front-loading washers, tumble action moves clothing through the wash water. The force of the drop from the revolving drum and the water action remove dirt. Rinsing is provided by a series of fresh water charges entering and leaving the drum. The drum speeds up to provide centrifugal force for water extraction in the spin-dry cycle.

Combination washer-dryers are basically front-loading, tumble-action washers, with additional electrical circuitry and drum design provided to dry the clothing after it has been washed by the same machine. After a decline for several years, combination sales are now on an increase. These reliable and efficient machines save space and dry clothing without the need for transfer to another machine.

Because top-loading automatics are the most popular type now in use, and because most repair principles would apply to other types as well, we will be primarily concerned with these machines. We will make our diagnosis first from the symptoms of the machine, then from further tests in the areas where the particular problem is likely to occur. Symptoms are listed in the order they are most likely to occur in the cycle of the machine.



Hinged tops on most newer automatics allow easy access to many components. The inlet valve, snubber or friction pad, lid switch, and many terminals in the wiring harness are serviceable from above.



Top may be snapped up with ease in most cases by depressing the locking clips with a thin-blade screwdriver as shown in the detail drawing above.

SYMPTOM: Water will not enter the machine

Check the obvious first: An inlet hose may be crimped, or perhaps a faucet is turned off. Water-inlet hoses have filter screens at the couplings. Sand or rust scaled off within the water line may have clogged the screens. Another filter is located in the inlet valve at the point where the hose attaches to the machine. Remove and clean these filters or replace them with new ones.

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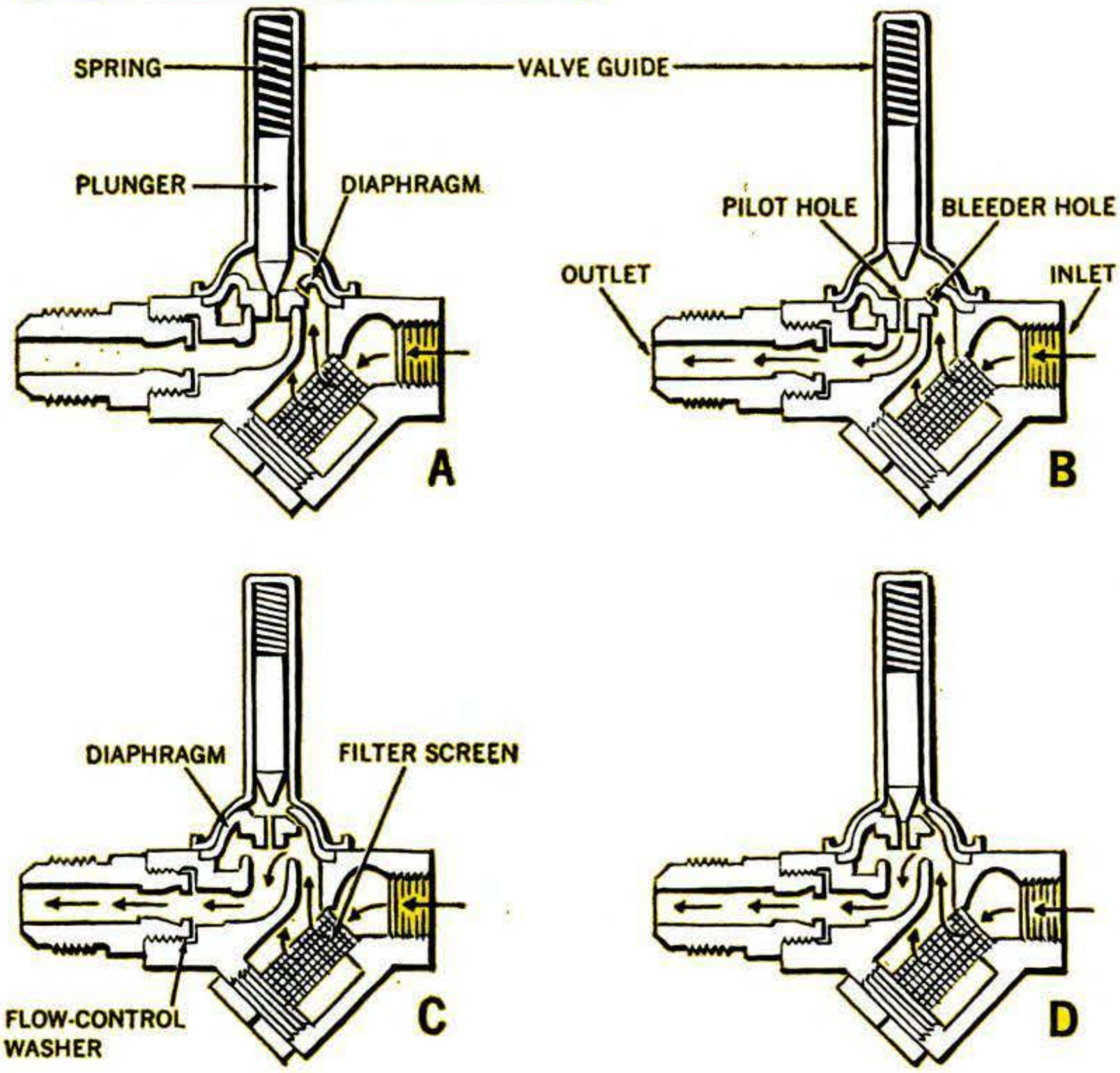
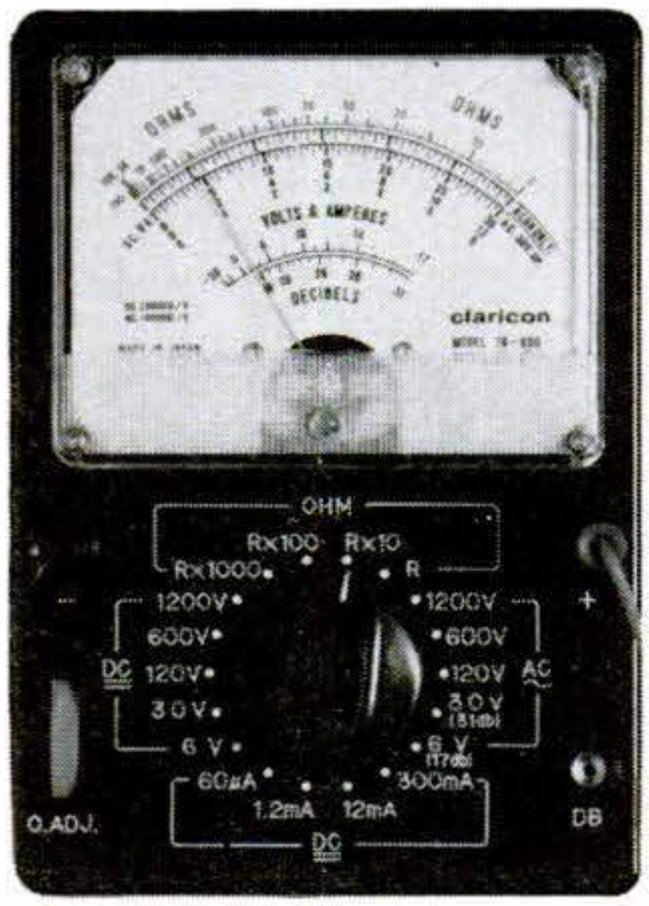
PS Extra: WASHER REPAIR



Water-inlet valve operated by a solenoid works as shown in this series of sketches. Starting with Sketch A, you find valve in its closed position. In B, plunger has risen to open the pilot hole, and water in the valve guide escapes. In C, pressure of incoming water lifts the diaphragm and the valve opens. In D, dropping of plunger closes the pilot hole, and pressure in the valve guide then closes the valve. Bleeder hole maintains balanced pressure on both sides of the neoprene diaphragm.

Still no results? Use your ears for a moment. Is there a low buzzing sound when the water should be coming in? If not, go to the water-inlet valve. To get to this valve, you must raise the top of the washer. Whirlpool and Sears machines, and some newer models of other makes, are hinged at the rear. A slight forward and upward pull will release the top from its front holding clips and allow it to pivot. Most others have screws at the rear of the top. Remove these screws, raise the top at the back, and slide it forward. Before exposing any electrical connections in this manner, *always unplug the machine.*



Inexpensive volt-ohm meter such as this gives reasonably accurate measurements. Care should be taken not to drop or jar the instrument. For tips on how to use such a meter, see last month's POPULAR SCIENCE.

Water-inlet valves in automatic washers are operated by a solenoid. When current flows through this coil, a magnetic field is created, raising a plunger inside the valve and allowing water to flow into the machine. When the magnetic force is removed, spring action seats the plunger and the water flow is shut off.

Your washer will have one, two, or three of these solenoids, depending on the number of water-temperature selections. To check the coils, look for the wires leading to the water valve. Each coil will have two wires connected to its terminals. Check the coils for continuity and ground with your meter.

From this point we will use the term "continuity" to refer to a resistance test of components. Continuity means that the electrical circuit or wiring under test is not broken, or open. To make the test, set your ohm-meter on R X 10, or the closest approximate scale denoted by R

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or Ω (the symbol for ohms). Then touch the two leads to the terminals under test after first removing one wire to prevent feedback from other sources. A full-scale, or approximately full-scale, deflection of the meter should be noted.

Practice this with a light bulb. When you touch one meter lead to the shell of the lamp base and the other to the center contact, the meter needle will sweep to the right if the lamp is good, just as if you had touched the leads together. With a burned-out lamp, no deflection will be noted. Now practice with fuses. This can be especially useful with a cartridge fuse, which has no indicator to show whether the fuse is good or open.

A deflection should occur when the meter leads are placed across the terminals of a solenoid, denoting electrical continuity through the coils of wire within. To check for a ground, touch one meter lead to the frame of the cabinet, the other to each of the solenoid terminals in turn. No meter deflection should occur, showing that there is no electrical leakage to ground. If either test shows that the solenoid is faulty, remove the screws that connect it to the valve and replace it with a new one obtained from your dealer.

If all checks well, refer to the wiring diagram on the machine for a component marked "water-level switch" or "float switch." This switch controls the amount of water entering the basket. The diagram shows one of the wires from the switch leading from the timer, and another leading to the inlet-valve solenoid or to the water-temperature switch. Continuity should be read across these two terminals with no water in the basket, and with one of the wires disconnected at the push-on terminals. Now go to

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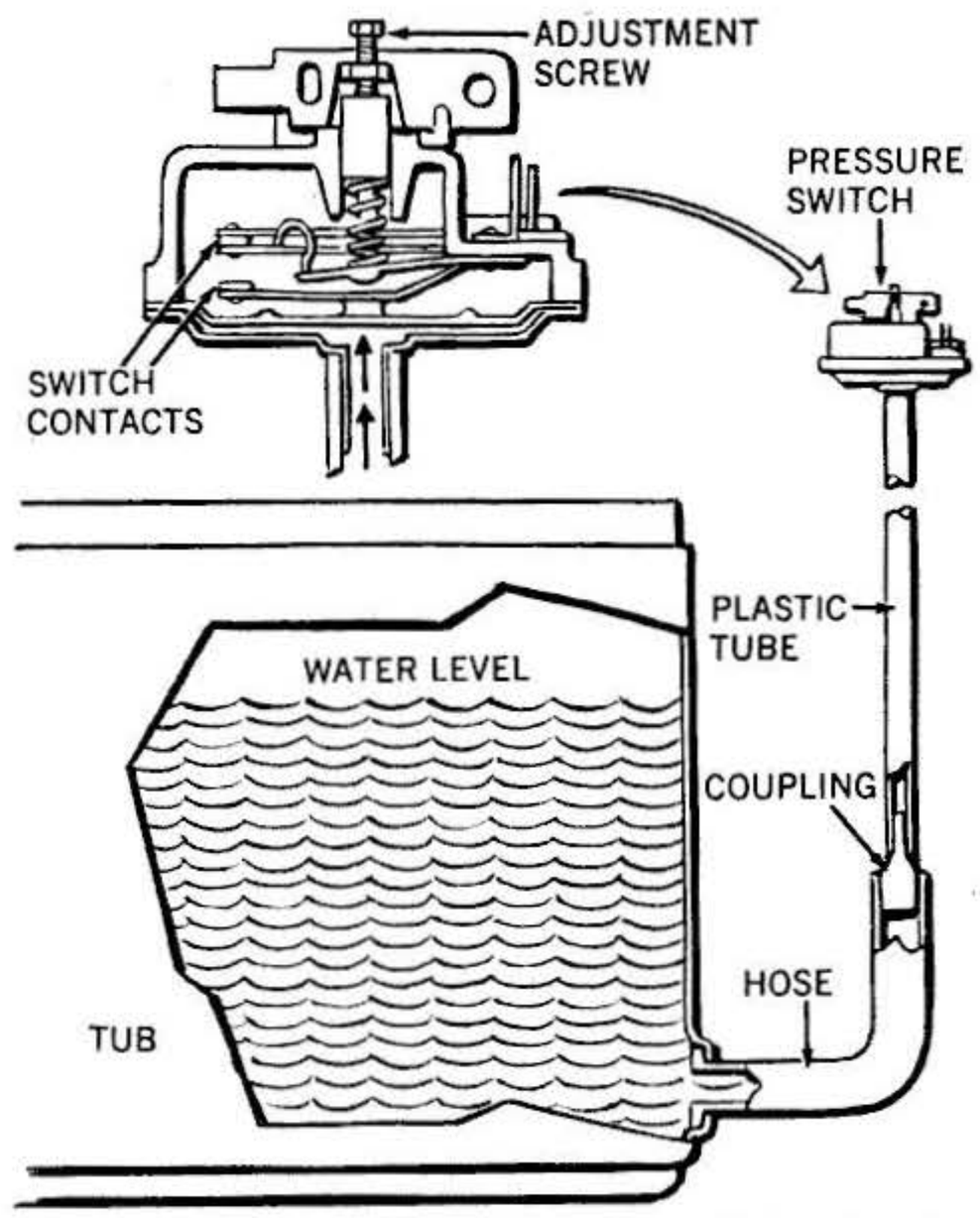
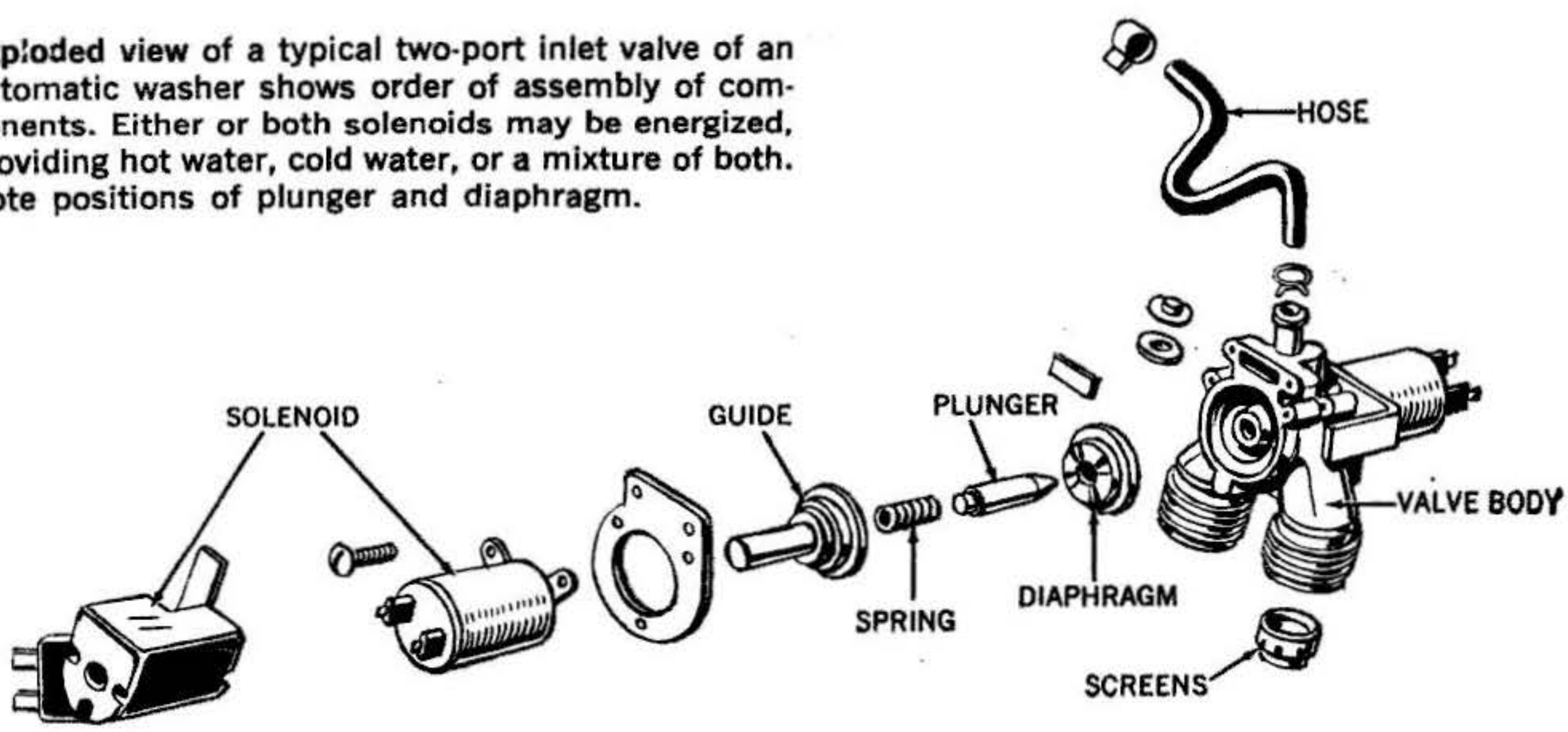


How a pressure switch works: As weight of water in tub increases, air pressure in sealed tube moves a diaphragm, which in turn activates switch contacts to control water level. Once set, the adjustment screw will rarely have to be calibrated.

Exploded view of a typical two-port inlet valve of an automatic washer shows order of assembly of components. Either or both solenoids may be energized, providing hot water, cold water, or a mixture of both. Note positions of plunger and diaphragm.



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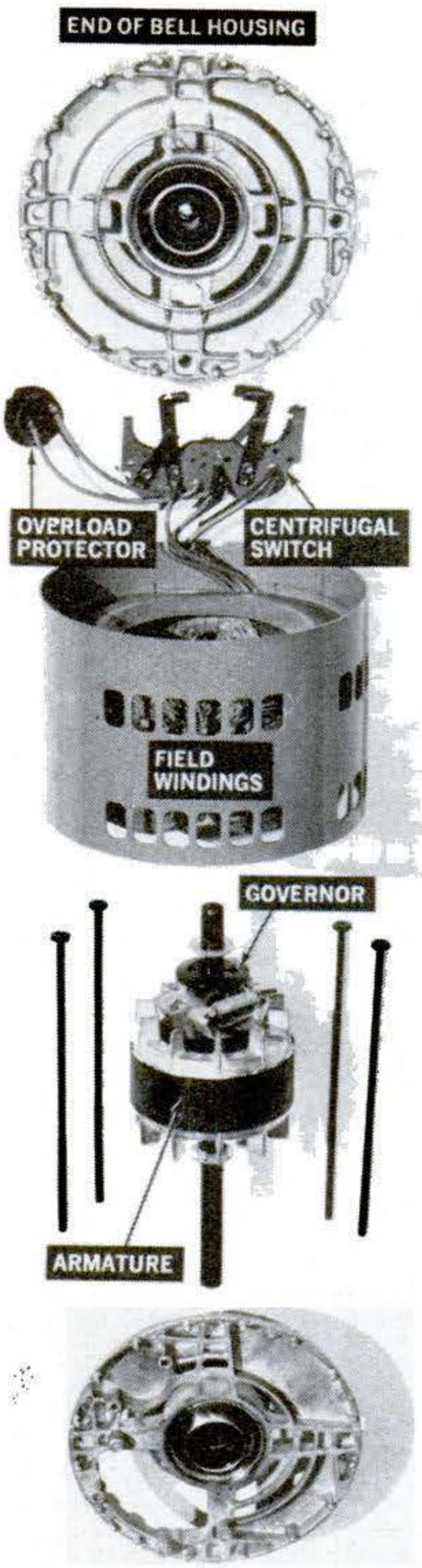

In typical split-phase motor, governor on the armature controls the centrifugal switch, which serves to break circuit to the starting windings when the motor approaches normal running speed. Many motors now have a centrifugal switch that may be replaced without disassembling the motor.

the water-temperature switch, and check for continuity from the terminal from the water-level switch to the terminal leading to the solenoid in question.

Keep in mind the short cuts possible when you use one of the best test instruments available—your own ears. Listen to the machine. If you hear a slight hum, the solenoid is buzzing. This tells you that the solenoid, water-level switch, timer, temperature switch, and other electrical components are good. The problem is mechanical. Check for a restriction in the water line. By the same token, should no hum be heard, eliminate the mechanical operation of the water-inlet system and devote your time to testing the electrical components with your meter. Applying your efforts and thinking along this line makes your diagnosis more accurate and much quicker, and prevents traveling up many blind alleys. It's as easy as 1, 2, 3. Observe, listen, and analyze accordingly.

SYMPTOM: Water will not shut off (machine overflows)

Unplug the machine. If the water flow does *not* shut off, the problem lies in the water-inlet valve. These valves depend on balanced water pressure on both sides of a neoprene diaphragm, which in turn is controlled by the solenoid-operated plunger. To allow pressure balance, small 'bleed holes' are designed into the diaphragm. If a small grain of sand or particle of rust manages to escape the filters in the water line and lodges in these ports, the plunger is incapable of shutting off water flow. Small things like this can disable any washer.

To clean the valve, remove it from the machine by uncoupling the fill hoses and any other connecting hoses. Remove the quick-disconnect wiring terminals, noting the color-coded wire for each solenoid. Then remove the two screws holding the valve to the cabinet. Disassemble the valve, observing the positions of diaphragms, plungers, and springs, and flush each part (including the valve body) under running water.

If the water flow *did* shut off when the machine was unplugged, check the solenoids on the inlet valve for a ground. There should be no indication that a ground is present. Then check the tube from the tub to the water-level switch to be sure that it is not restricted. If these checks fail to uncover the problem, the water-level switch is faulty and should be replaced.

SYMPTOM: Machine will not run at all

If the light doesn't come on, check for the presence of voltage at the receptacle—a fuse may be blown in the circuit. Put the volt-ohm meter on the 125-volt or 250-volt AC scale, and insert the leads into the receptacle. It should read approximately 115 volts. Then check the two conductors in the power cord and plug. After unplugging the machine, follow the cord to the point where the leads connect to the terminal block or the timer. Check for continuity from each terminal to one of the blades of the plug. If the cord is defective, replace it with a heavy-duty appliance cord with a grounded-type molded plug at-

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tached. Be sure to follow the color code. Never use a small lamp-fixture cord or an extension cord on an automatic washer.

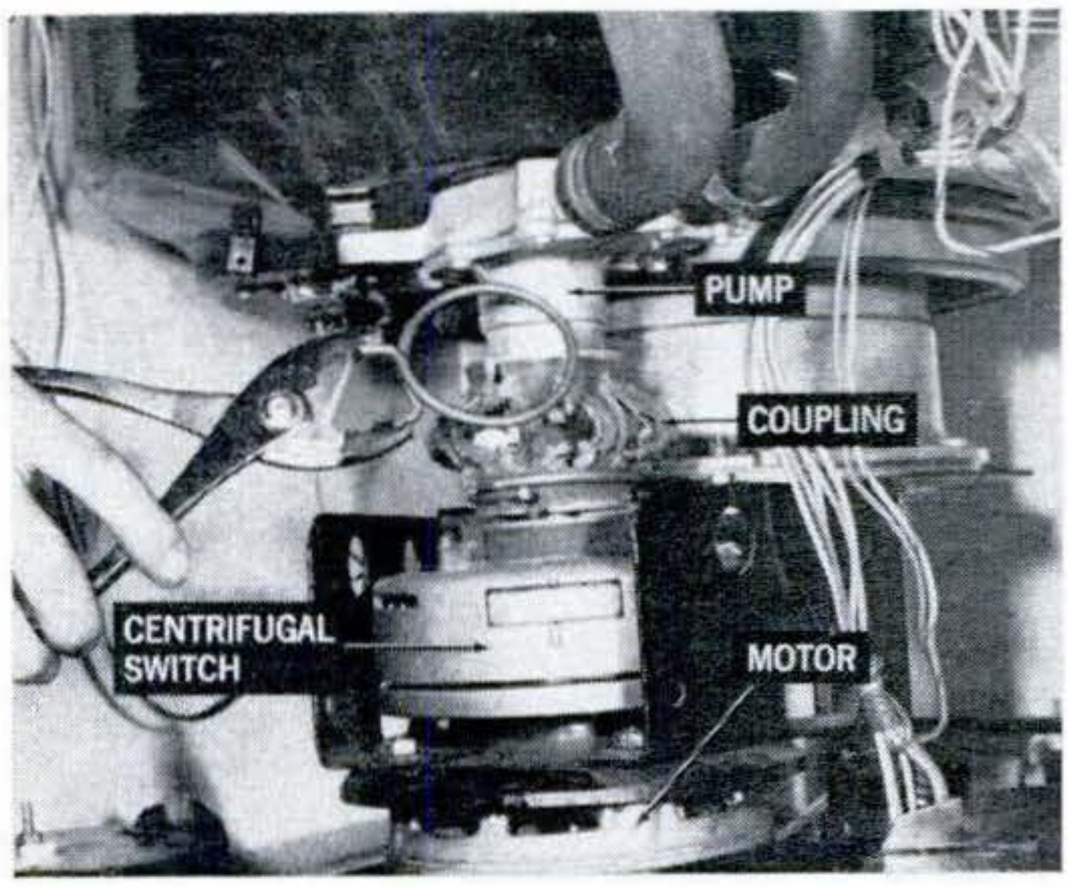
The next check would be at the motor. If it hums but does not run, or if your volt-ohm meter shows that voltage reaches the terminals of the motor, remove the belt and see if it will run. If it does, check the other belt-driven components to see if one is locked or binding. If it does not, remove the motor and take it to a motor-repair shop for inspection. Many motor problems are due only to faulty centrifugal switches or capacitors, which may be replaced at a fraction of the cost of a new motor.

If the motor runs but does not drive the belt, the motor pulley may be loose on the motor shaft or the belt may be loose or broken. In either case, you will be able to see the problem area. A loose belt is tightened on most machines by loosening the bolts that mount the motor to the superstructure, and moving it back to reduce the slack. As a rule of thumb, most belt tensions are correct when the belt may be depressed about half an inch at midpoint between the two pulleys.

Some machines have a spring-loaded device, usually a pulley, to maintain constant belt tension. If the belt stretches enough to slip, it must be replaced.

If the belt is broken, or has a flat spot from slipping over a period of time, replace it. This may appear at first glance to be quite a job on some machines. Actually, it's usually simple. Always loosen the motor mount or idler pulley that applies belt tension. Then remove the belt from the pulleys. On General Electric machines you'll have to remove one of the spring clamps from the flexible coupling that drives the water pump. Do this with spring-clamp pliers.

On Whirlpool and Sears machines, a spacer is provided on one of the three studs that mount the gear case to the superstructure. Remove this one spacer and the two bolts that hold the water pump in place. This will allow the belt to be removed from all but one obstruction—the basket-clutch shaft. Move the extractor cam bar toward the rear of the machine so that it is completely free from the shaft, drop the shaft down to free the belt, unhook the tension spring, pull belt free. Reverse this to install a new belt. Save the largest pulley for last—a new belt easily slips on if you turn the pulley with it in place.



Pump coupling on a General Electric washer must be removed to service the pump or clutch, or to replace the belt. Use hose-clamp pliers to remove the large spring-type clamps that retain the coupling.

GE pump assembly is easily serviced after removal from the bottom of tub. Internal flapper valve, which diverts water flow either to filter or to drain line, is controlled by direction of motor rotation.

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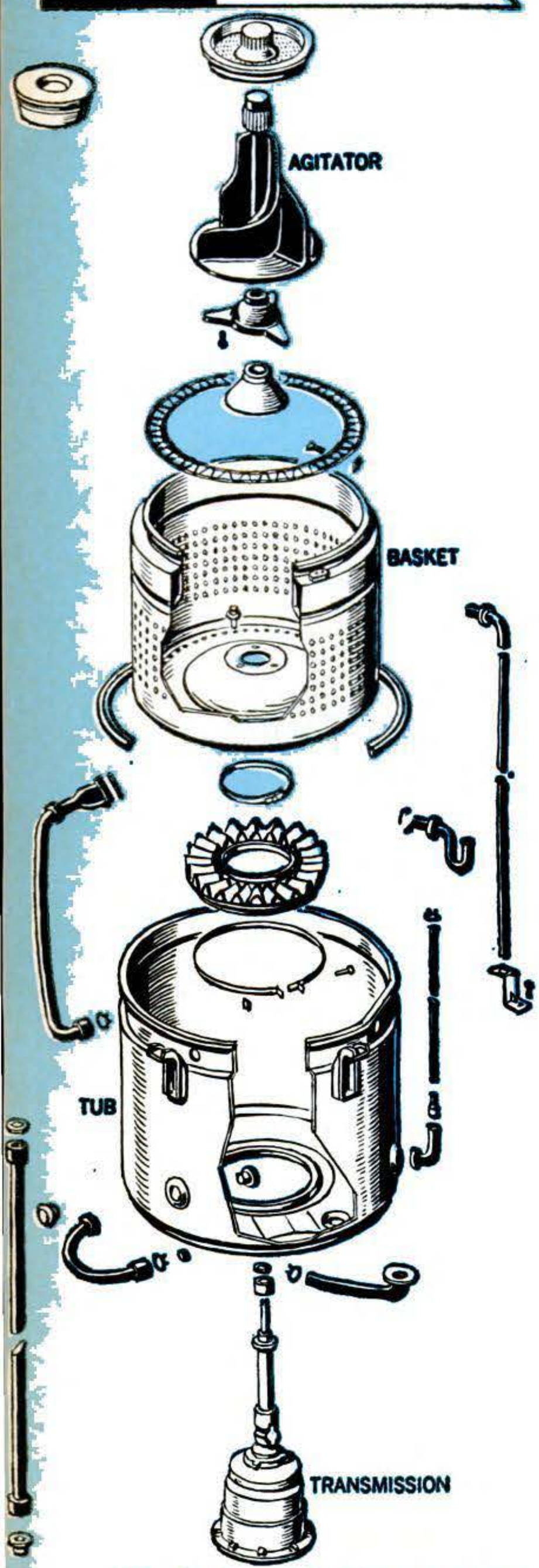

Exploded view of tub and basket assembly shows much of the water system of an automatic washer. To check for leaks, all hoses, boots, and seals must be inspected. It is important, especially in case of a small leak, to try to locate area before moving machine.

SYMPTOM: Machine will not agitate

Two methods are used to change from one cycle to another—by using solenoids to shift the mechanism upon a signal from the timer or cycle control, or by reversing the direction of motor rotation. A quick observation will determine which of these methods your machine uses. If solenoids are used, determine from the wiring diagram which one controls agitation. Watch its action when the timer is placed in the wash position.

If you can see its movement, you know that the solenoid coil is good and that the circuit through the timer is functioning. Check its mechanical linkage for a broken or binding link or a broken cotter pin. If no movement is observed, move the solenoid manually to be sure that the armature, or plunger, is not binding. If not, check the coil for continuity, and also check each of the two wires back to the timer.

If yours is a motor-reversal-action machine, look to see if the rotation is actually reversing in the wash and spin cycles. Always check to see if the pulley driving the gear case is turning the shaft to which it is attached. Most pulleys are locked to their shaft with Allen-head setscrews. Check the belt or belts to be sure they are not slipping.

If these observations show that the external controls of the transmission are functioning, or that the agitator is engaging but slipping, then the problem lies in the gearbox itself. Any repairs in this area should be left to a competent service technician. Such repairs are best done by a service organization that specializes in your brand of washer.

SYMPTOM: Timer or cycle control will not advance

Check the control by turning it manually to be sure the timer shaft is not binding. If it is, apply a drop of oil carefully to the point that is causing it to bind. Never use more than a drop of oil, and never allow it to get near the electrical contacts in the timer.

Timers are driven by a small synchronous motor and a gear train, called an escapement, which advances the timer in sudden movements every one or two minutes, depending upon design. This reduces arcing at the contacts of the various switches by breaking them suddenly, rather than slowly. The timer motor is located in back of the timer in the washer console. It should be checked for continuity, and if faulty it can usually be replaced. If, however, your test shows that the escapement is broken or slipping, the complete timer assembly will have to be changed.

SYMPTOM: Lint filter will not operate

Most late-model automatics have a filter in the water system to reduce the amount of linting from fabrics. Operating at all times when the machine is washing or rinsing, the system removes water from a tub outlet, pumps it through the filtering device and back into the washer basket. Valving devices in the pump control the water

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flow and direct it either to the filter or to the drain outlet. On motor-reversal types, the pump will discharge the water when turning in one direction to provide spinning action, and to the filter when turning in the opposite direction for agitation.

Naturally, if something happens to stop water flow through the filter, the filtering action will stop. On most machines, you can see the water flow back into the machine if it is functioning correctly. On others, you must visually check the components in the filtering system to be sure the passages are not clogged.

Some fabrics, such as terry cloth, flannel, etc., give off large amounts of lint. Others, such as corduroy, hold lint. Lint givers and lint holders should not be washed in the same load, as the lint will become attached to the nap of the lint-holding fabric before it gets into the water stream where it can be filtered. If a problem with linting is encountered, a fabric softener added to the rinse water will do much to eliminate the condition, especially in the case of wash-and-wear fabrics.

As we noted, some automatics drain water through perforations in the basket before spinning. Others spin the basket while still filled with water, the resulting centrifugal force acting to force the water over the top of the basket and into the tub, to be pumped from the machine into the drain line. It sometimes happens that a small article of clothing goes over the top along with the expelled water and blocks the drain outlet.

When this occurs, it is usually first noticeable as a loss of filtering recirculation. To remedy, raise the top of the machine, push the basket to one side, and "go fishing"; reach into the tub and feel for the clothing at the outlet, or perhaps floating in the water, and pull it free. If a guard is present at the outlet, be sure not to remove it when the clothing is taken out.

If this problem occurs frequently, check the manner in which your washer is loaded. Remember, it is water circulation through the fabric that does the cleaning. Therefore if the clothing is loaded correctly it will tumble and move through the water in the machine as it is circulating. If the machine is overloaded, the agitator will simply move in the middle of a pile of clothing, and little water action will be observed. This is the easiest and most practical way to judge any clothes load.

The rating of washers in pounds is excellent as an industry standard, but is of little value in everyday washing. It's similar to the old riddle: "Which weighs the most, a pound of lead or a pound of feathers?" While 18 pounds of a heavy denim material may not reach the capacity of your washer basket, 18 pounds of nylon quilting may not even get into your washroom, let alone the washer. If you've any doubt about a particular load, observe the water circulation and clothes movement—if both are active, there is no need to be concerned about overloading.

If loading habits are correct, and a problem still occurs with clothing passing over the basket, consult your

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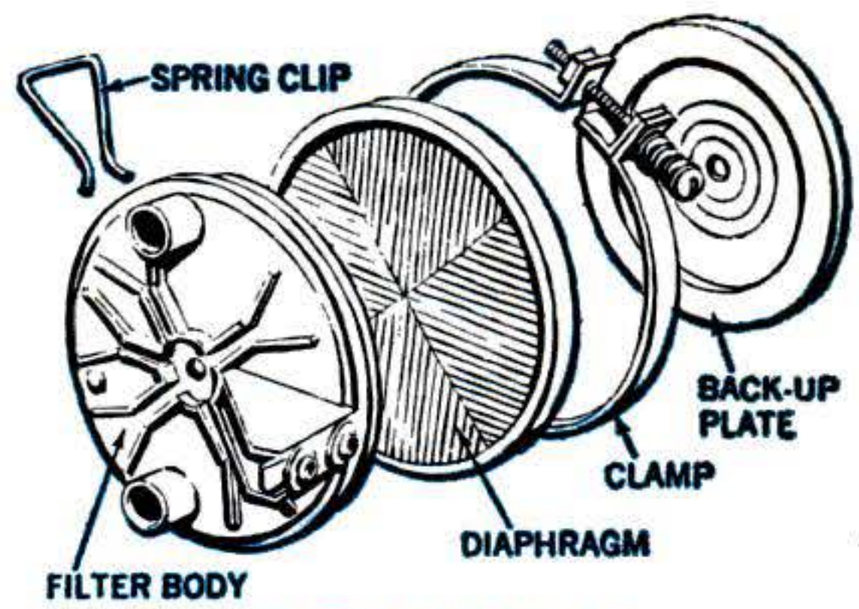
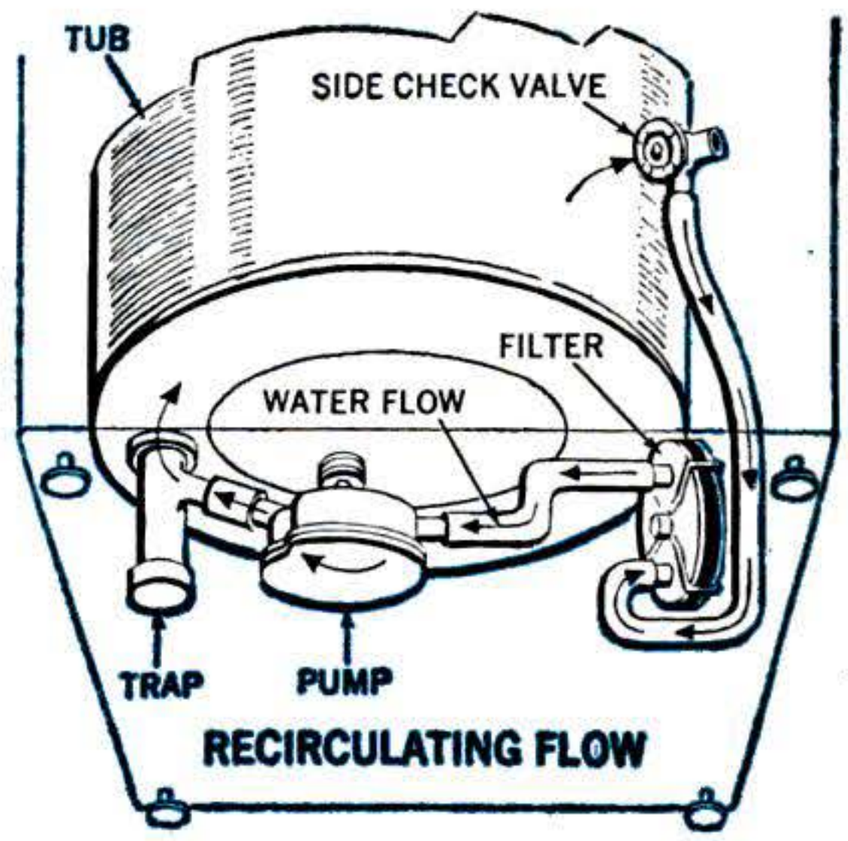
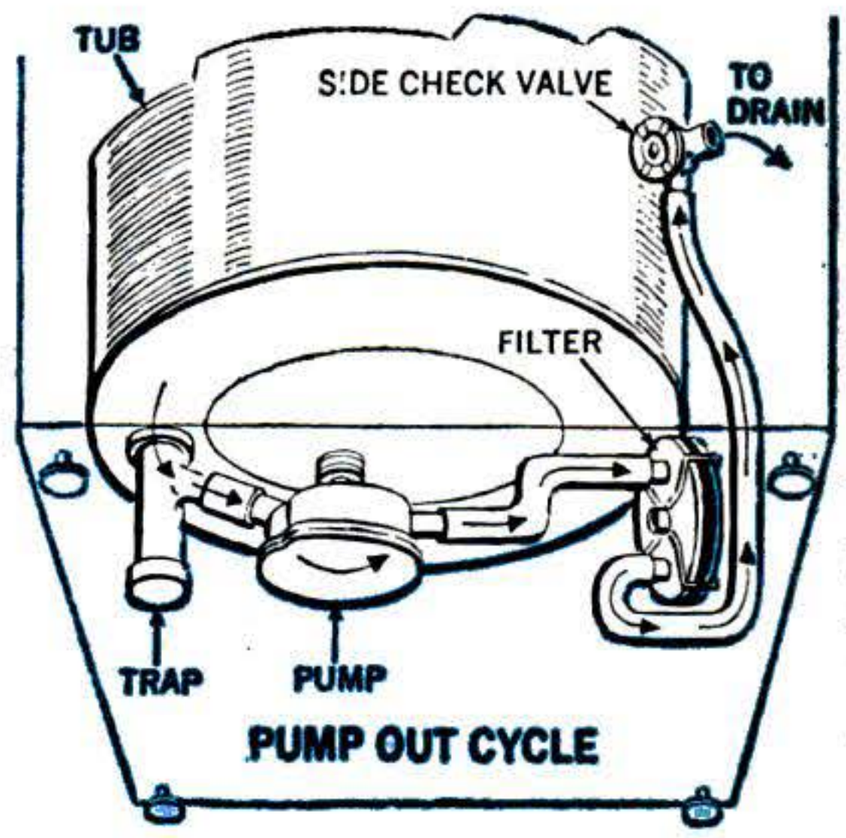


FILTER ASSEMBLY



RECIRCULATING FLOW



PUMP OUT CYCLE

Self-cleaning lint filters on some newer washers offer high efficiency and convenience. In Whirlpool's Magic Clean at top, diaphragm contracts during washing and rinsing as water is recirculated from side check valve through filter and pump and back into bottom of machine (middle drawing). Contracted diaphragm allows water to pass but traps lint contained in water stream. When valve in pump reverses water flow as at bottom, diaphragm expands and releases trapped lint which flows to drain.

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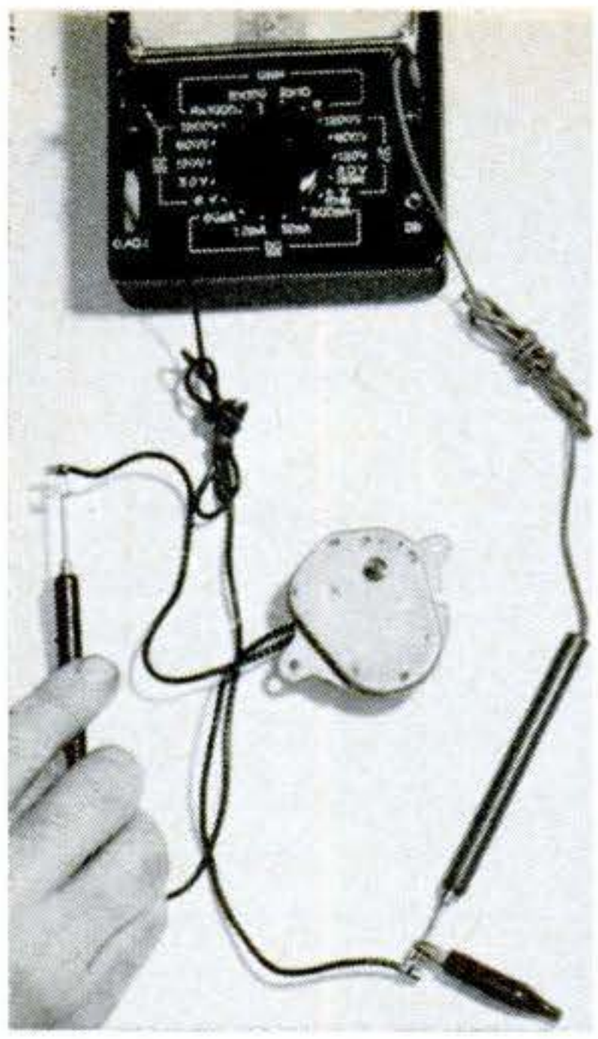
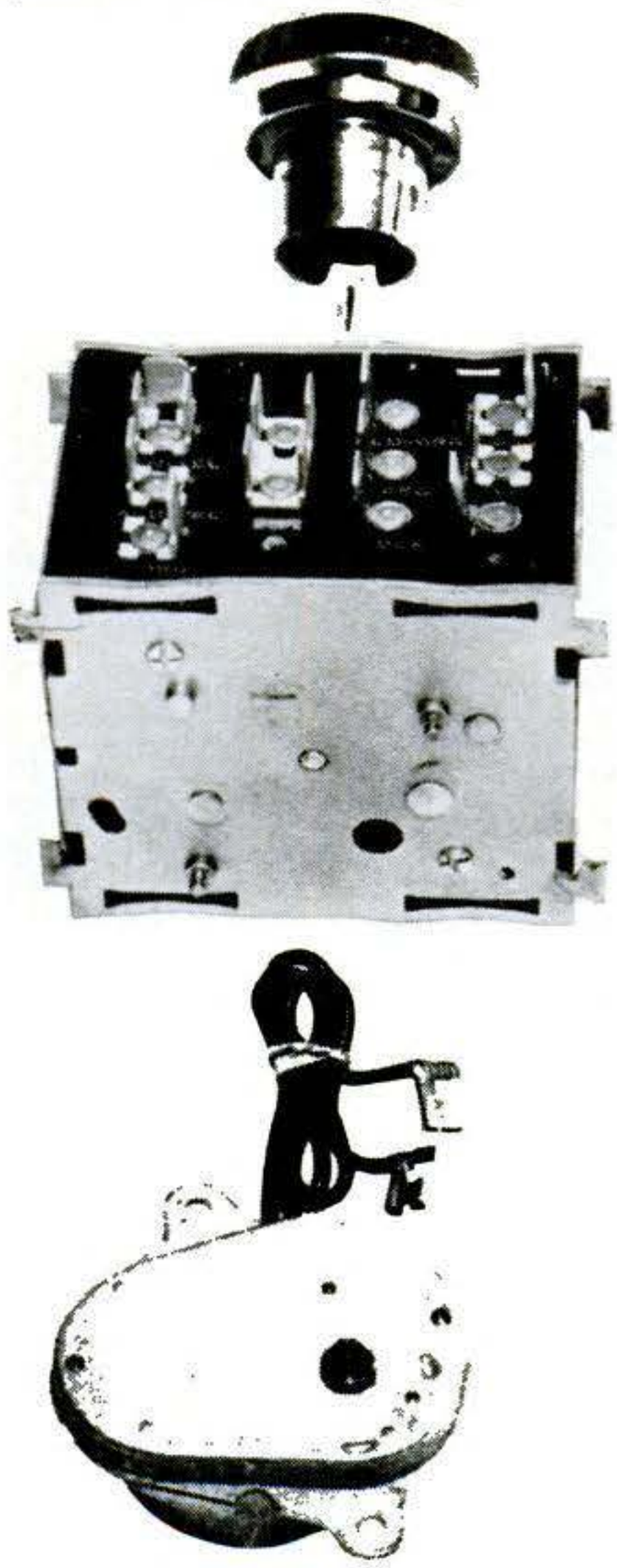


Typical timer for automatic washer has three main parts (shown from top to bottom in photo below): knob, switch, and motor. In most cases the motor may be replaced. Burned switches usually call for complete timer replacement. Photo above shows timer motor being tested for continuity. Replace it if circuit's open.



manufacturer. Most have a guard used on their commercial equipment which can be adapted to home washers.

If passageways to and from the washer pump are clear, and still no recirculation occurs, check the pump and its linkages. The pump is easily located by following the large outlet from the bottom of the tub. See if the pump coupling or belt is tight. The pump should turn easily by hand. If not, remove it by unfastening the attachment bolts, and remove the screws that hold the pump together.

Be sure no foreign objects have gotten into the pump and locked the impeller, which should turn easily. Impeller and pump body should be inspected visually for pitting and cracking. Valves should operate smoothly and positively. Whenever disassembling a pump, replace any seals that show a sign of leakage. Lubricate the impeller shaft and linkages. Cork gaskets must be replaced—rubber O-ring gaskets may be re-used if not damaged.

SYMPTOM: Water leaks from machine

An axiom of washer-service technicians is that "leaks are where you find them." Since the appliance is using water in some manner during most of the cycle, notice carefully at what point the leak occurs. This will give a clue as to whether the leak is in the inlet system, the tub, or in the drainage system. Then, before the machine is moved, try to look under it with a flashlight to see the general location of the drip.

Check the inlet hoses before and after a fill period—heat expands the fittings and sometimes the couplings may leak only at this time. Also check the drain standpipe—it may need to be cleaned out. If you have an intermittent leak and suspect the standpipe, tie a rag around it. The next time an overflow occurs, the rag will absorb water and remain wet for several hours, while the hot drain line will dry very quickly.

Should the leak be in the machine, look for wet spots or a white stain left by detergent after the water has dried. If a hose is deteriorated it may be cut off and temporarily used. But replace it as soon as possible.

SYMPTOM: Water will not pump out

Check to see if the filter water is recirculating. If not, check the same areas that you would for loss of filtration: pump, pump valves, pump belt, pump coupling, or restriction in water lines leading to the pump. When replacing the flexible pump coupling on GE washers, always install the new coupling with the fabric side out.

If water recirculation does exist, only two possibilities remain: The pump valve is not shifting from the recirculate position, or the drain line from the machine to the laundry tub or standpipe is crimped or clogged.

SYMPTOM: Machine will not spin-dry

Check visually to see that the motor-reversal or solenoid action is occurring to shift the basket drive mechanism. Inspect the linkages to see that they are not bent, broken, or rusted. If they are, replace or lubricate them

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so that they operate smoothly. Check the spin solenoid for continuity. If no solenoid action occurs, check the wiring harness for continuity, and then check the contacts within the timer as designated in the wiring diagram. The lid safety switch may be the culprit here. On some washers, it shuts off the entire machine when the lid is raised; on others, the spinning action only is stopped. To check it, locate the switch and check for continuity while holding it in the position it would be in with the lid shut.

If the basket spins slowly but does not pick up speed, see if there is water or detergent in the outer tub. If so, the braking action of the friction against the surface of the basket can slow the speed greatly. Oversudsing can be remedied by filling the machine with fresh water, then pumping the water back out. If oversudsing is extreme, this may have to be done several times. Also check for the possibility that clothing may have gone over the basket and wrapped around the basket hub. To detect this, you have to reach as far under the basket as possible, after first raising the top.

Another cause of slow spin could be a loose belt or slipping clutch. Automatic washers with a centrifugal-clutch mechanism (similar to that used on gasoline engines for power mowers, karts, etc.) generally provide no adjustment—the clutch linings have to be replaced if they are slipping. Those that use a dry-disk-type clutch to drive the basket provide an adjustment on the clutch linkage. There should be about ⅛-inch clearance between the lining and clutch pulley when in the agitate position.

SYMPTOM: Excessive vibration and/or noise

Automatic washers are designed to absorb quite a bit of the shock of an unbalanced load without transferring movement to the cabinet, very much as an automobile is designed to absorb the impact of road bumps without transferring the chassis movement to the body structure. In both instances, however, if the movement is severe enough the suspension cannot absorb it all. Therefore, the first thing to do if vibration occurs is to rearrange the clothes in the basket. When washing heavy, highly absorbent items such as throw rugs, wash several at a time. Although the load itself will be heavier, the increased volume of several pieces will allow the water movement to place them around the basket for balance.

Inspect the levelers on the machine. It should be approximately level, and should rest solidly on the floor.

One of the most difficult problems you may encounter is trying to locate a noise when the machine appears to be functioning normally. The best clue will be to notice the point in the cycle where the noise occurs. Note whether it is pumping, spinning, or agitating at that point, thus at least eliminating components that could not be involved. Often it is helpful to use a makeshift stethoscope. Take a large screwdriver and place the driving end on the metal housing near the area where the noise seems to originate, and hold the handle near your ear. This little trick has helped me pin down many evasive noises.

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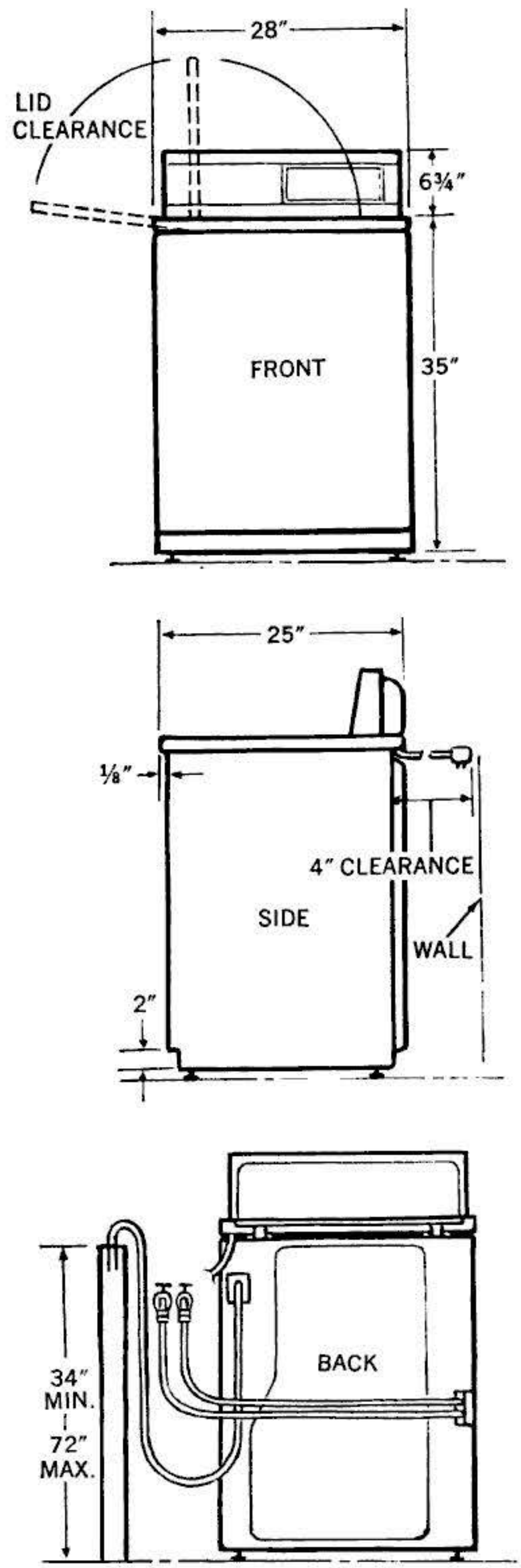

When buying a washer, compare dimensions with available space. Otherwise built-in convenience may be lost. Supply faucets, drain pipe, and the grounded receptacle should be close. Drain pipe should be approximately 34 inches high to prevent siphoning of water.

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PS Extra: WASHER REPAIR

The suspension system of a washer, like an automobile, consists of springs or suspension bars and shock absorbers in the form of friction pads or snubbers. This system can be the source of assorted squeaks and pops. The snubber pads should be dry and unglazed. If not, clean them and roughen the surface with a file or on a cement surface. Coil springs, which may develop a tendency to squeak, can be treated with a little grease.

Some squeaks or squeals can be traced to the belt. Check to be sure that there is proper tension, and if necessary, use a belt dressing. Never apply oil or grease to a belt or to a clutch lining.

A few words of caution: When servicing home appliances, always be sure the equipment is unplugged when any electrical connections are exposed. Be sure the grounding wire to the cold-water line is intact before plugging a washer into the receptacle.

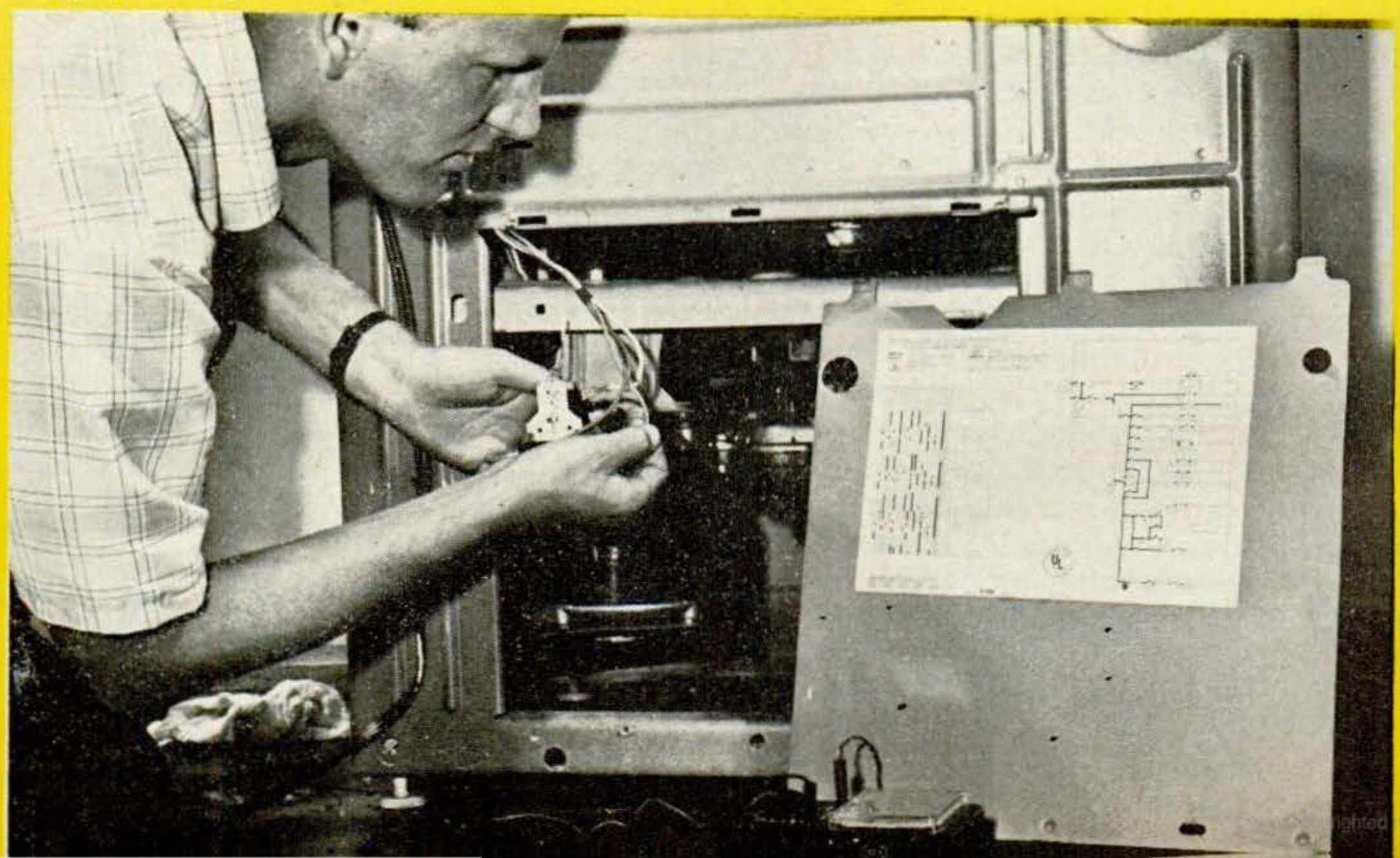
Never use the console or backsplash of a washer to handle or move the machine; this may chip the porcelain-enamel finish. Use an old blanket or quilt to protect the finish and the floor whenever it is necessary to lay the machine down; always lay it on its front.

Do not remove the third (round) ground prong from the power cord of an appliance.

And, finally, it is usually not wise to make any mechanical repairs that may be carried under the manufacturer's warranty. You should, however, check to see that voltage is reaching the electrical outlet and that hoses are not crimped, and make any other checks that are normally considered the user's responsibility.

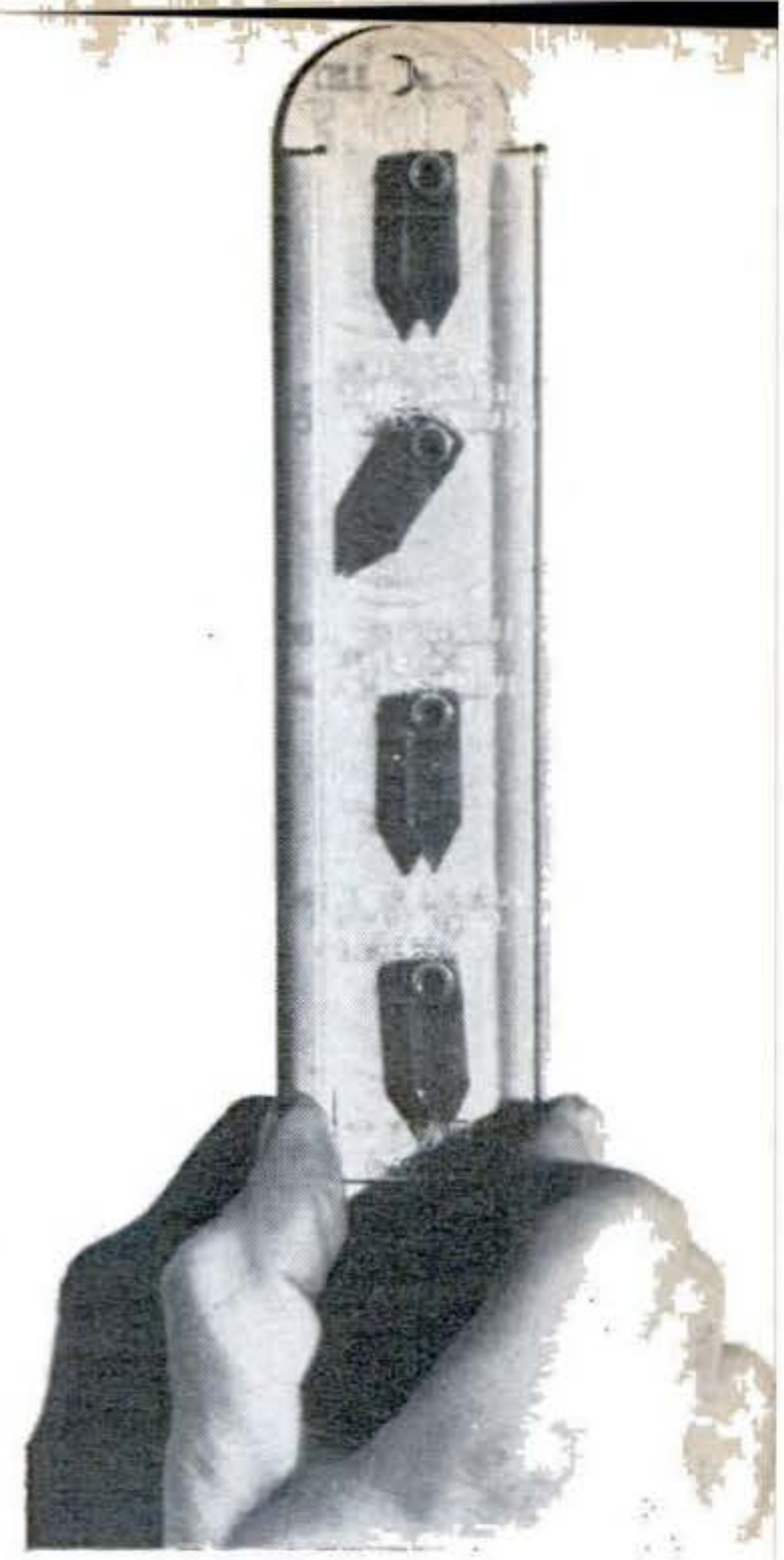
Should you have any question regarding your appliance, or should you wish to purchase a shop-service manual for it, you will find that the manufacturer will be glad to help you. The address of the factory will usually be located with the model-number tag on the appliance. Always mention this number whenever you write or call regarding your appliance. PS

Wiring diagrams and cycle charts, generally located at rear of the appliance, can be your best friend. While no standard diagram arrangement is employed, most have been simplified so that all the components are recognizable, along with proper wiring connections.



Shop Talk

By ROBERT P. STEVENSON



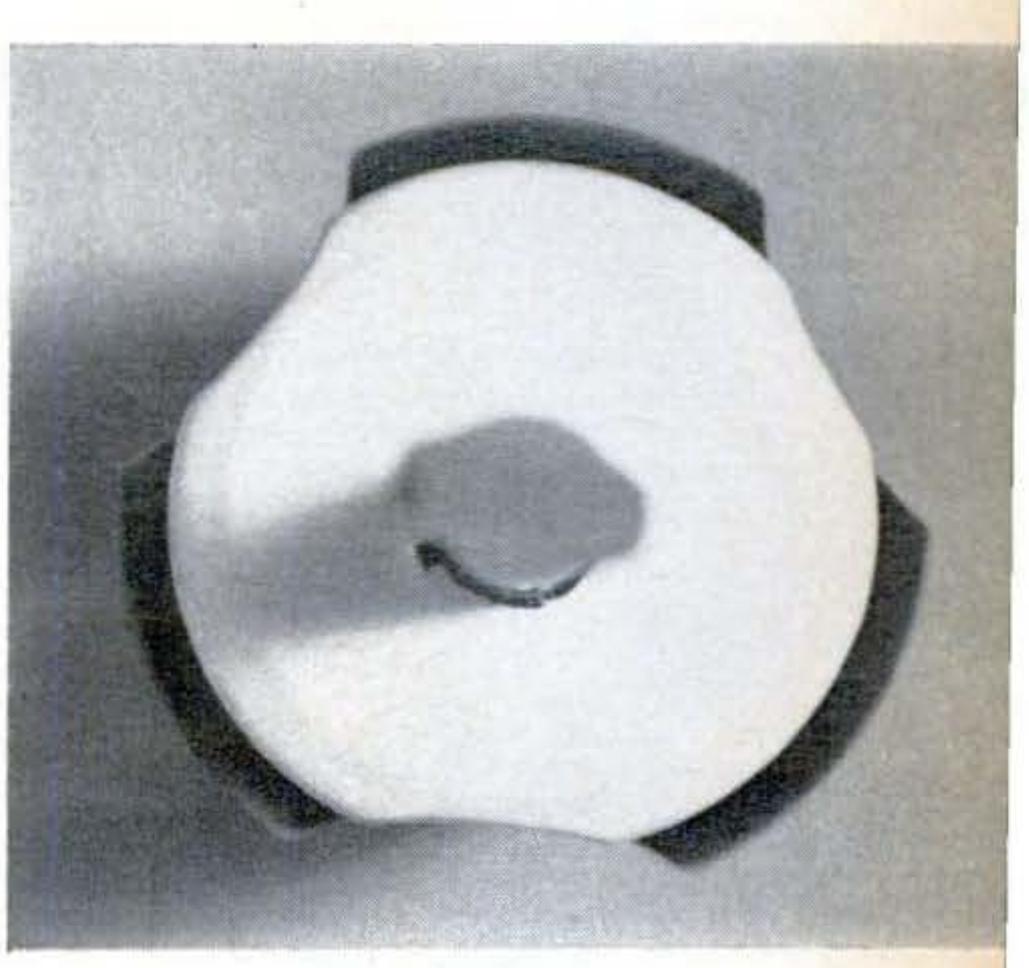
There's now a surefire stud finder for drywalls

To hang a heavy object on a plasterboard wall, you *must* find a stud. A new spotting tool does this nicely. A variation of an idea that someone else tried to market a few years ago, this finder has four pivoted magnetic pointers in a plastic case. Place the case vertically with its open back against the wall and move it slowly side to side and up and down. When you come to a hidden nail used to attach the plasterboard to a stud, a pointer is deflected. Mark this point and locate another nail above or below and you have the stud location. Eagle Rule Mfg. Corp., 510 Hunts Point Ave., Bronx, N. Y. 10474, makes the tool. Look for it in hardware stores. Price: 98 cents.

Dry lubricants in spray cans are first cousins of Teflon S

You may already have encountered new dry lubricants in small spray cans. They've been around for some time under such brand names as Slipspray (Du Pont), Slide-All (Borden's), and 3-in-One Dry Lube (Boyle-Midway). I've found them especially useful where wood slides against wood—double-hung windows and desk drawers, for instance. They're excellent, too, for lubricating mechanical actions where you want to avoid an oily residue that would collect abrasive dust and dirt. In the fine print of the caution label on each can you'll find that all contain a fluorocarbon telomer. This is derived from the same chemical building blocks as Du Pont's Teflon S. As you know, Teflon S gives extreme slipperiness to tool surfaces to which it is applied.

Brief notes about some new tools you'll be seeing



Take a look at that strange object in the photo at right. Can you guess what it is? If not, turn to page 198 and check out the new tools you'll find there. . . Now you can buy a chain saw with solid-state ignition. It's the Stihl Model 041 AV Electronic. Stihl American's regular Model 041 AV has built-in shock absorbers to eliminate vibration. The electronic system makes mechanical breaker points unnecessary . . . A diamond scribe, priced at $7.95 with a magnetic top and $6.95 without, is available for use by craftsmen in marking steel, gold, and other metals. It was introduced by Bulova Watch Co., Flushing, N. Y. 11370 . . . I've recently seen a neat drill stand with a polystyrene base and a quick-adjusting stainless steel clamp for holding the drill. Coastal Abrasive and Tool Co., Trumbull, Conn. 06611, prices it at $1.50. . . . At $37.45 list, Wen's Model 820K11 ⅜″ drill kit looks like a good buy.

Revised sixth edition of house-builder's "Bible" available

One of the most useful references on my personal shelf of books has always been Nelson A. Burbank's *House Construction Details.* So I welcome a revised edition, the sixth, now available from Simmons-Boardman Publishing Corp., 30 Church St., NYC 10007. The price is $14.95. Previous editions have sold more than 110,000 copies. The revision was done by Herbert R. Pfister, a former associate editor of POPULAR SCIENCE who still writes freelance articles for us.

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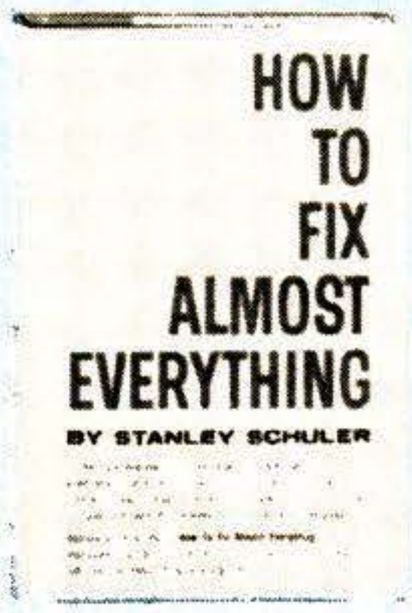
1 COUNTS AS ONE SELECTION



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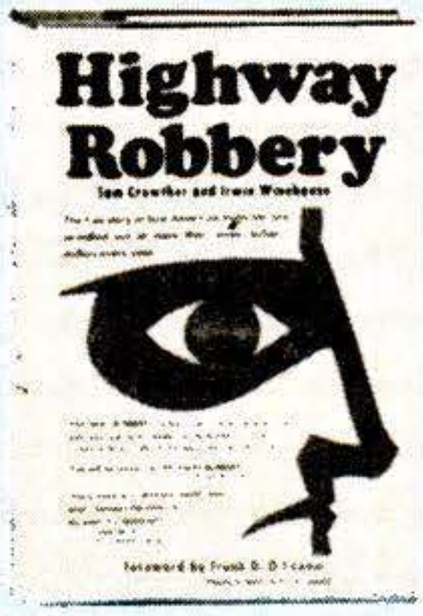

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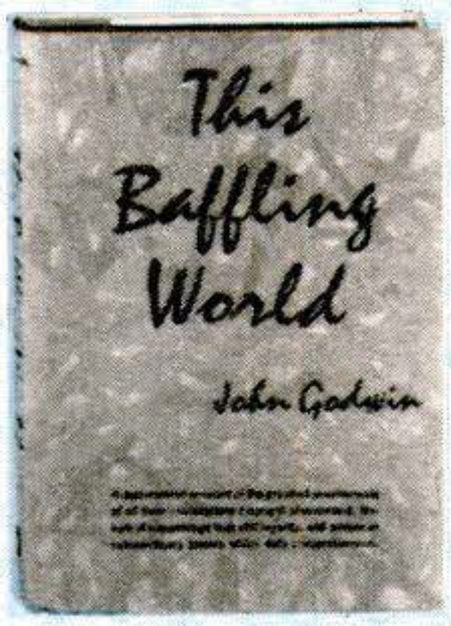

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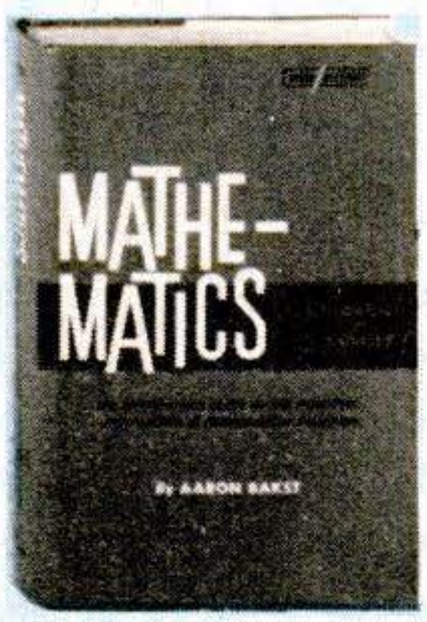

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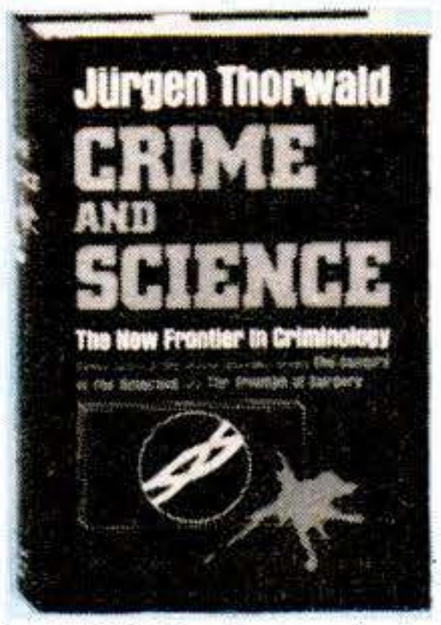

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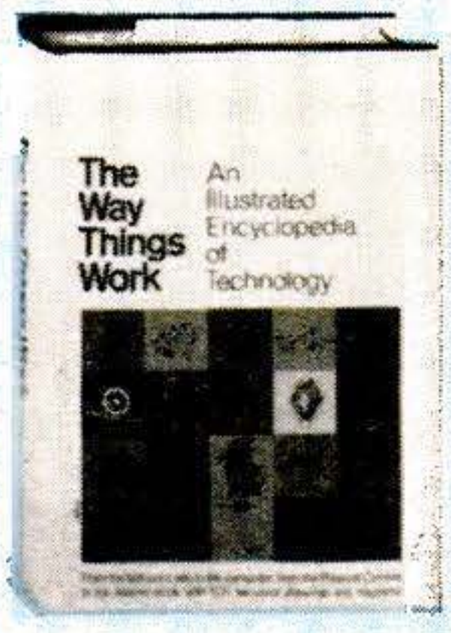

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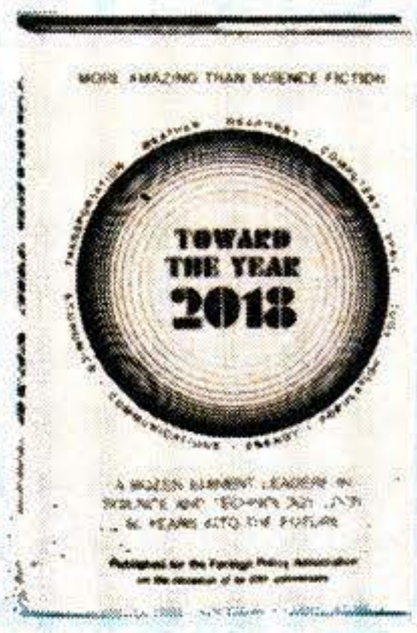

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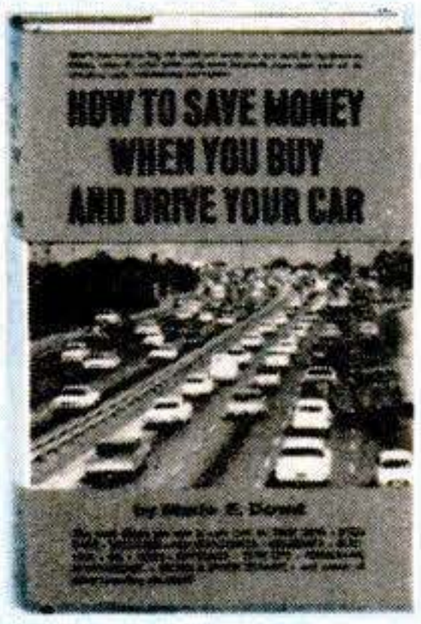

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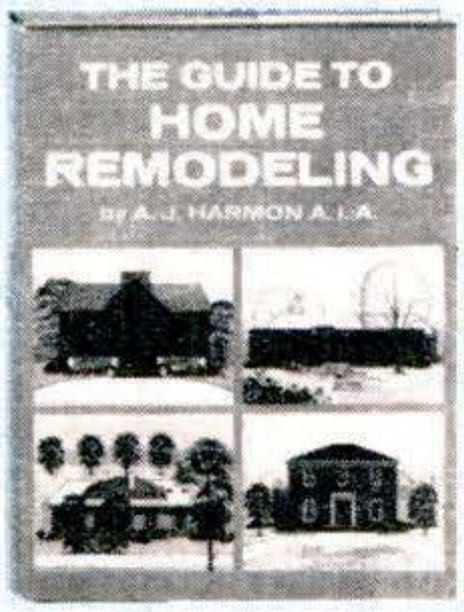

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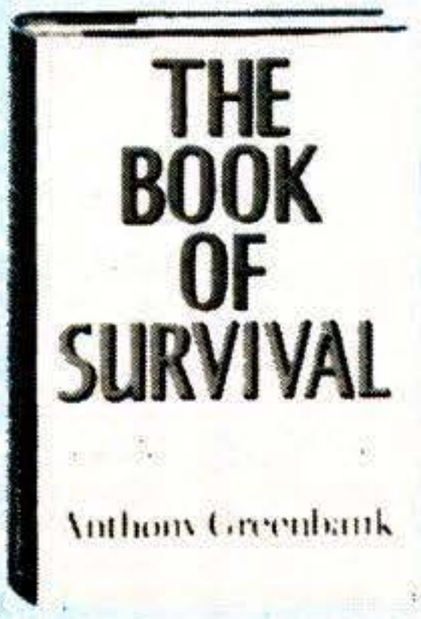

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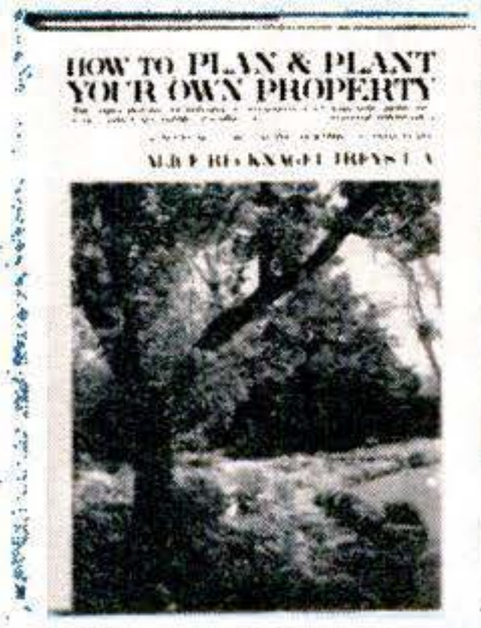

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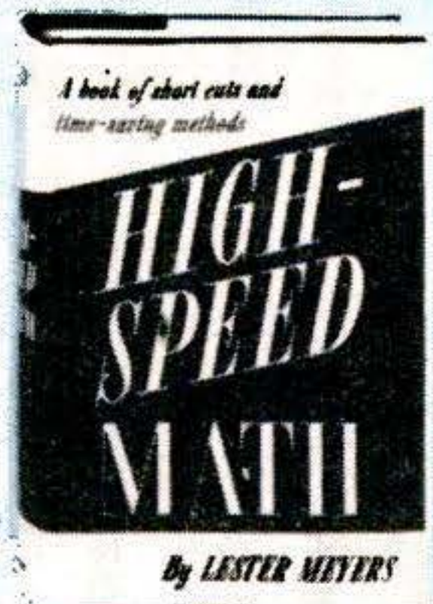

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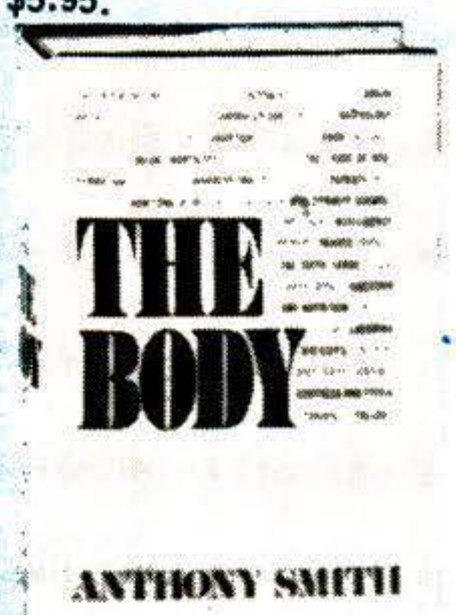

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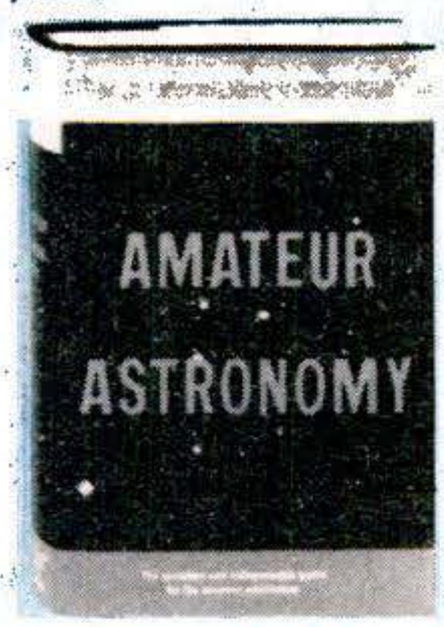

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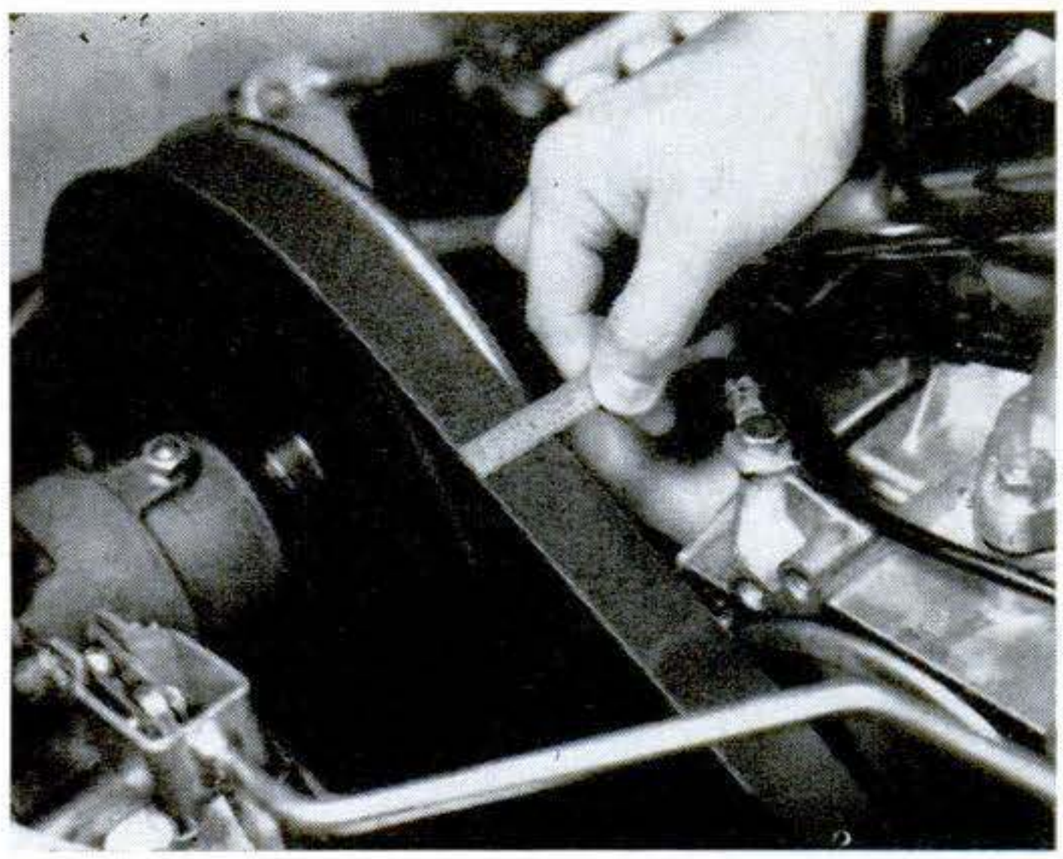
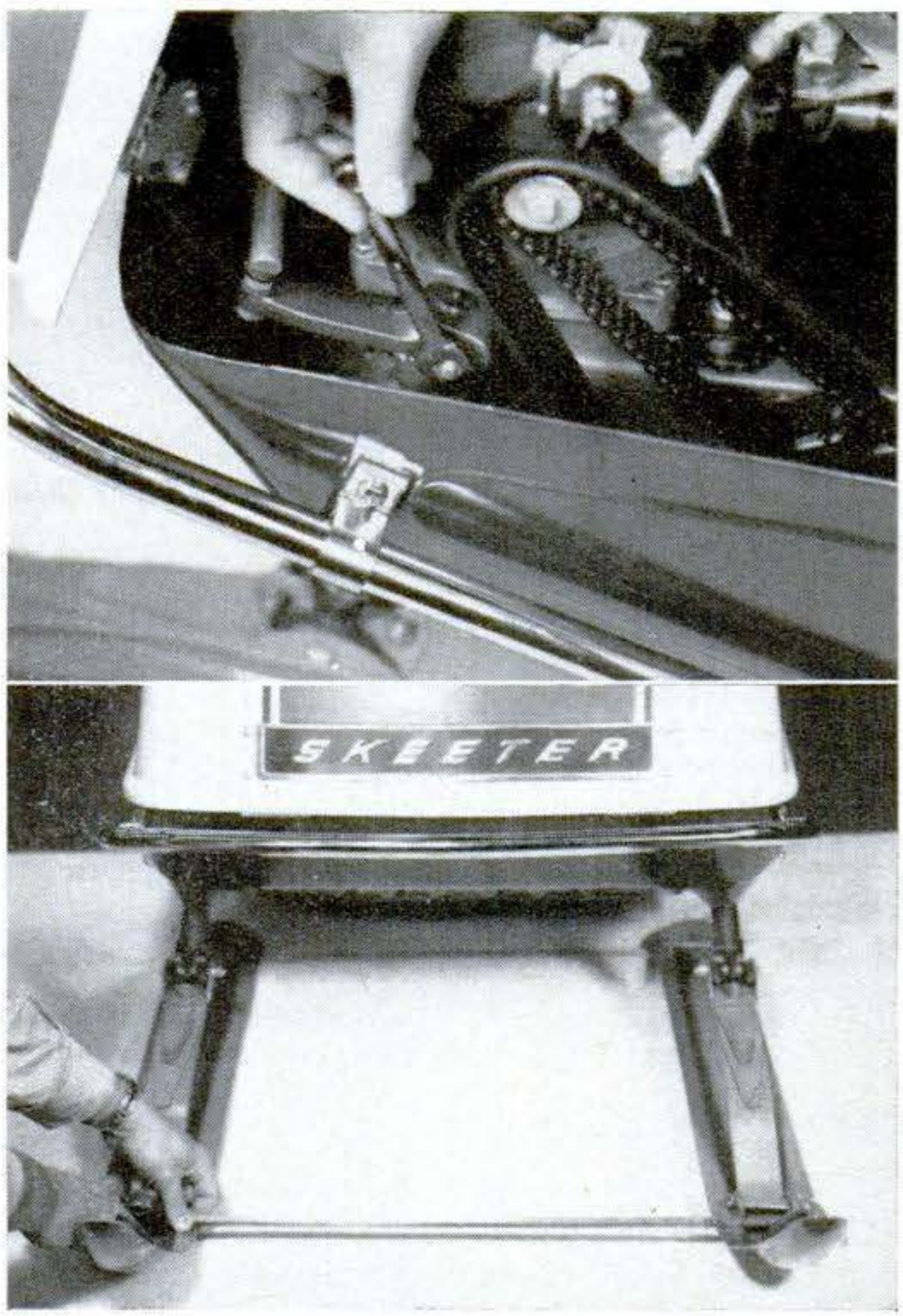
ABC's of Snowmobile



Transmission woes can be avoided by changing your drive belt before it breaks. The belt on an Evinrude (photo above) should measure 1½ inches across; when it wears down to less than ⅞ inch, it should be discarded and replaced with a new one.



Ski alignment can be checked easily by measuring inside distance between skis in front (lower photo) and in rear. If distance is equal or nearly so, they are in line. If out of line, place steering arm in straight drive position and loosen bolt (top photo). Place skis in parallel position and tighten steering-arm ball joint. While you're looking at the skis, check their entire length carefully for cracks.

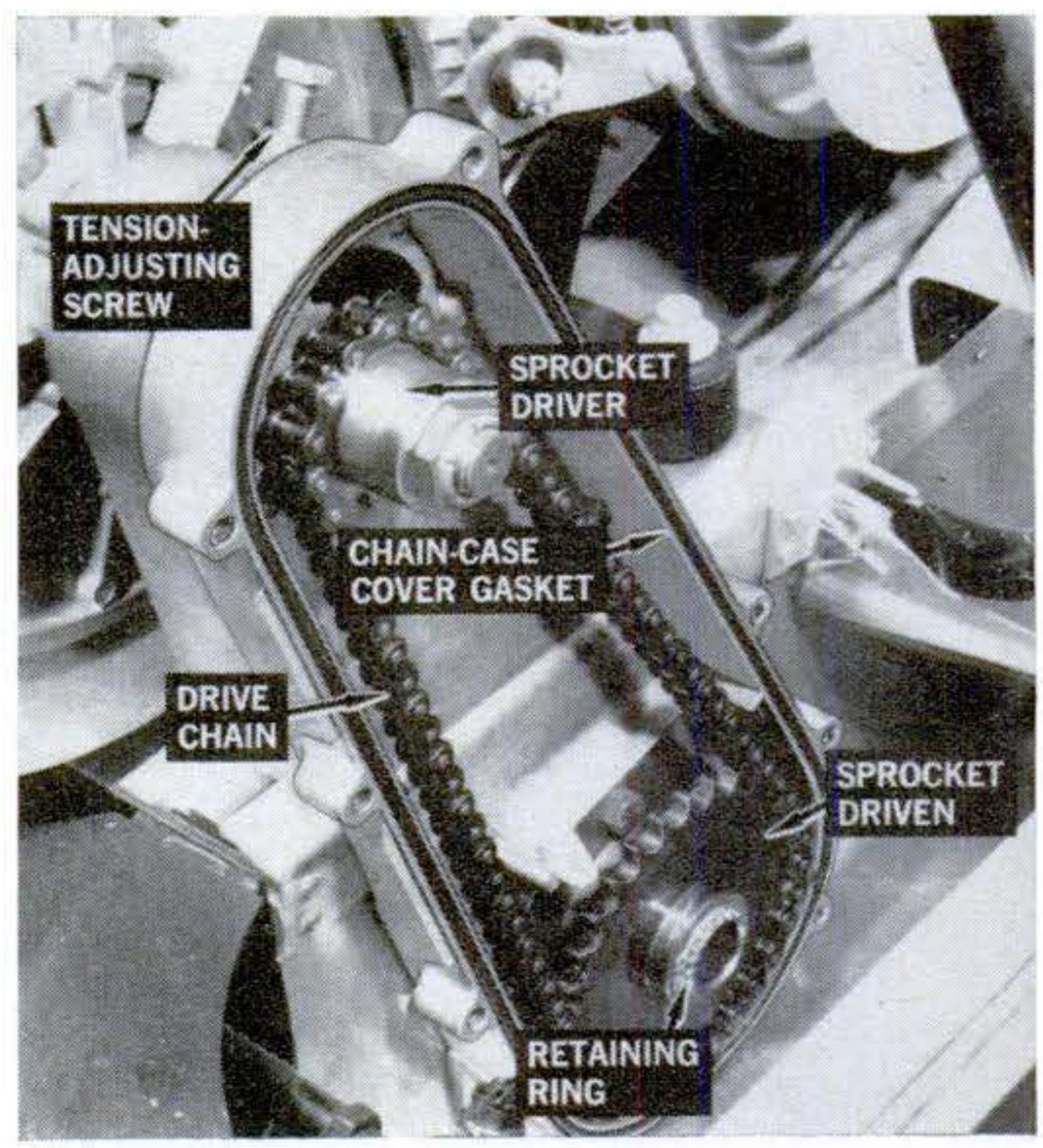
Here's how to spot and prevent some of the most common causes of trouble in these snow rigs

Dependability is the key to snowmobiling fun. Your vehicle not only must take you where you want to go, but get you back. In snow country, it's often impossible to get back any other way.

Two chief causes of breakdowns are the use of wrong gas/oil mixtures and ignition trouble. Here are some basic pointers that will help you to avoid these difficulties.

Mix oil and gas at room temperature. Use a 20:1 gas/oil ratio—unless your owner's manual recommends otherwise. Nondetergent auto oils, or one of the new snowmobile engine oils, are a must.

Ignition problems give rise to the snowmobiler's greatest complaint: hard starting. Engineers for Champion spark plugs suggest maintaining plug gap at mini-



Chain drive requires correct tension and lubrication level for proper operation. If the chain is overtight, it will cause wear on sprockets and chain. If it's too loose, the chain could "jump" teeth and damage the sprockets, chain, and chain case. Be sure to maintain oil-bath level in the bottom of the chain case with No. 10 engine oil. Remove the plug from the case to check the oil level periodically.

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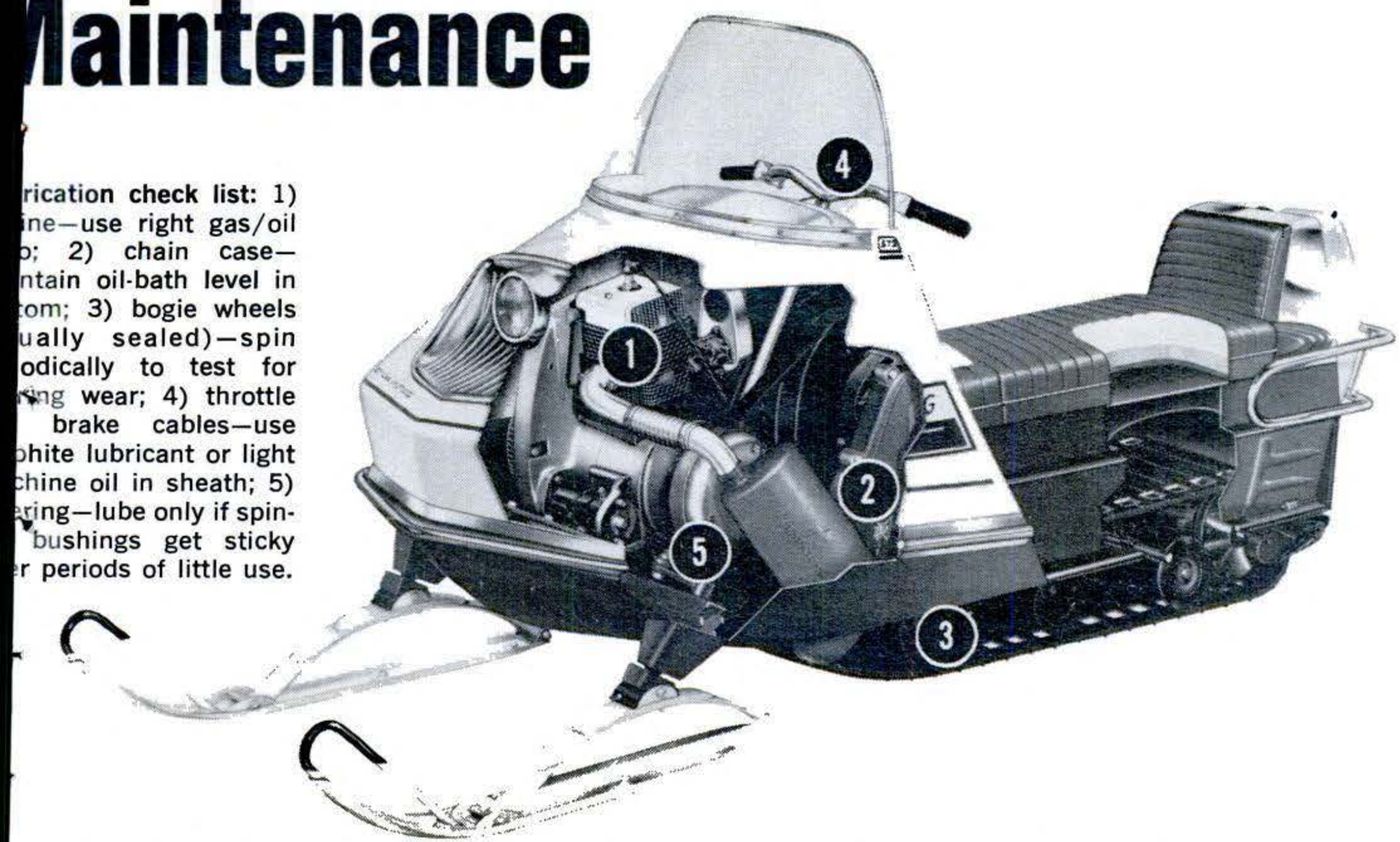
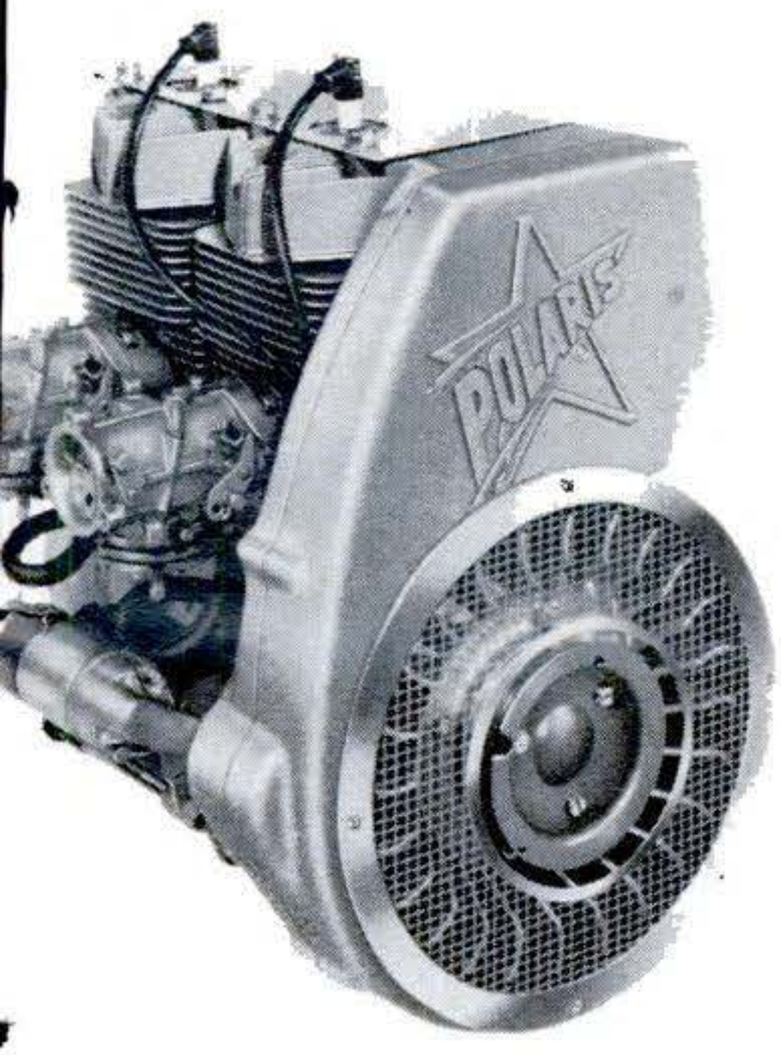
Maintenance



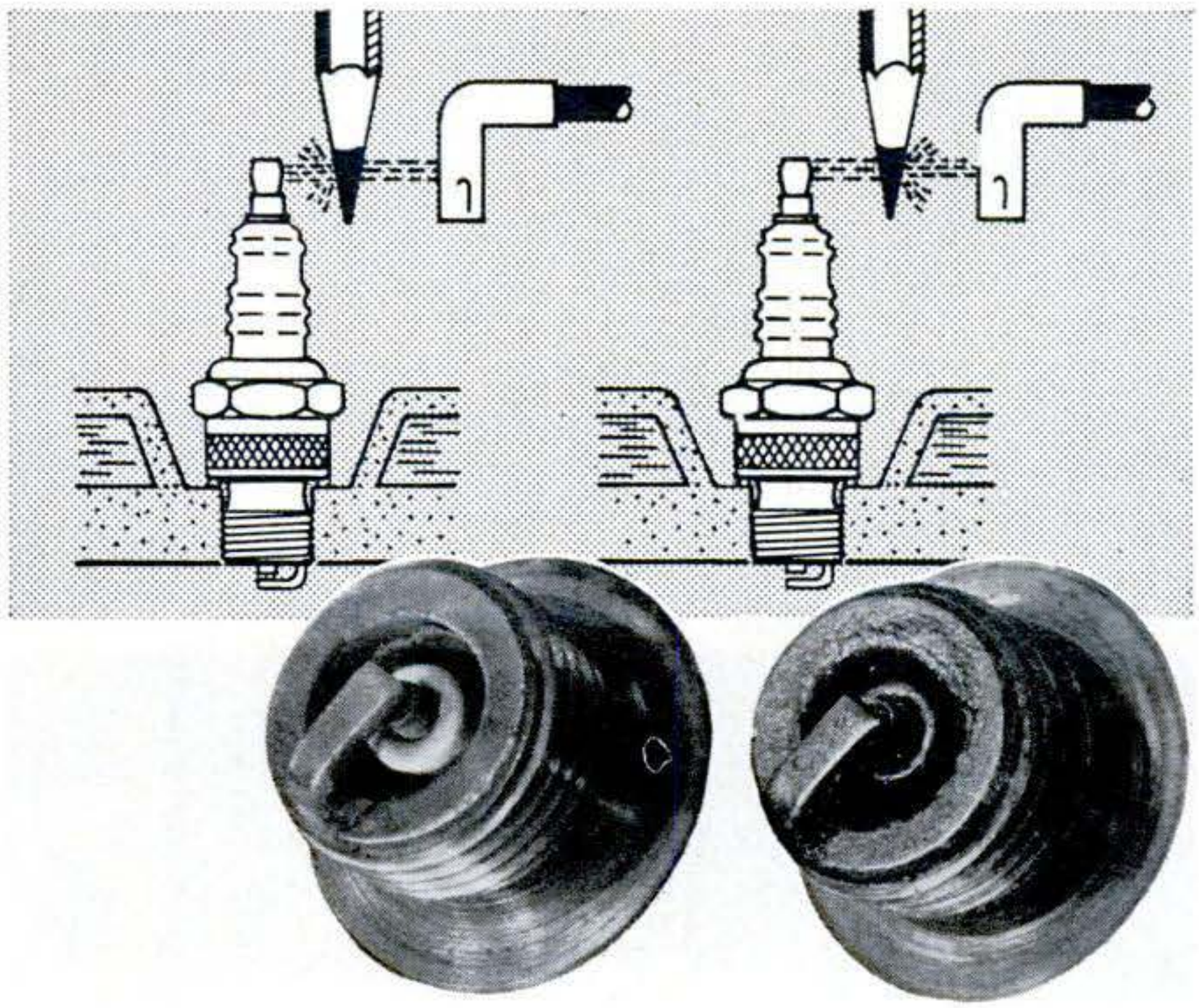
rication check list: 1) ine—use right gas/oil o; 2) chain case— ntain oil-bath level in om; 3) bogie wheels ually sealed)—spin odically to test for ing wear; 4) throttle brake cables—use hite lubricant or light chine oil in sheath; 5) ring—lube only if spin- bushings get sticky r periods of little use.

mum spacing. And to insure optimum ignition performance, check condition of breaker points, oil, condenser, magneto drive coils, and insulation of leads.

Other major parts of your snowmobile that require frequent inspection and maintenance to prevent breakdowns on the trail are shown in the cutaway (above) and in the accompanying photos and captions.—*Herbert Shuldiner.*



For carburetor adjustment, follow your owner's manual for preliminary idle and high-speed settings. Cautions: 1) Don't overspeed engine when vehicle is stationary. 2) Don't set high-speed needle too lean. This can damage engine and plugs, and hurt performance.



Correct coil polarity is necessary for top ignition performance. A simple test can be made with a wooden lead pencil (drawing). Place tip of pencil between plug lead and plug. If polarity is correct, the spark will flare from plug to pencil tip (left). If polarity is reversed, flare will be from pencil to wire. Examine plugs to determine how engine is performing. Under normal operating conditions, plug's insulator tip is a gray or light brown. Wet fouled plugs can be recognized by blackening. (Photos by Champion Spark Plug Co.)

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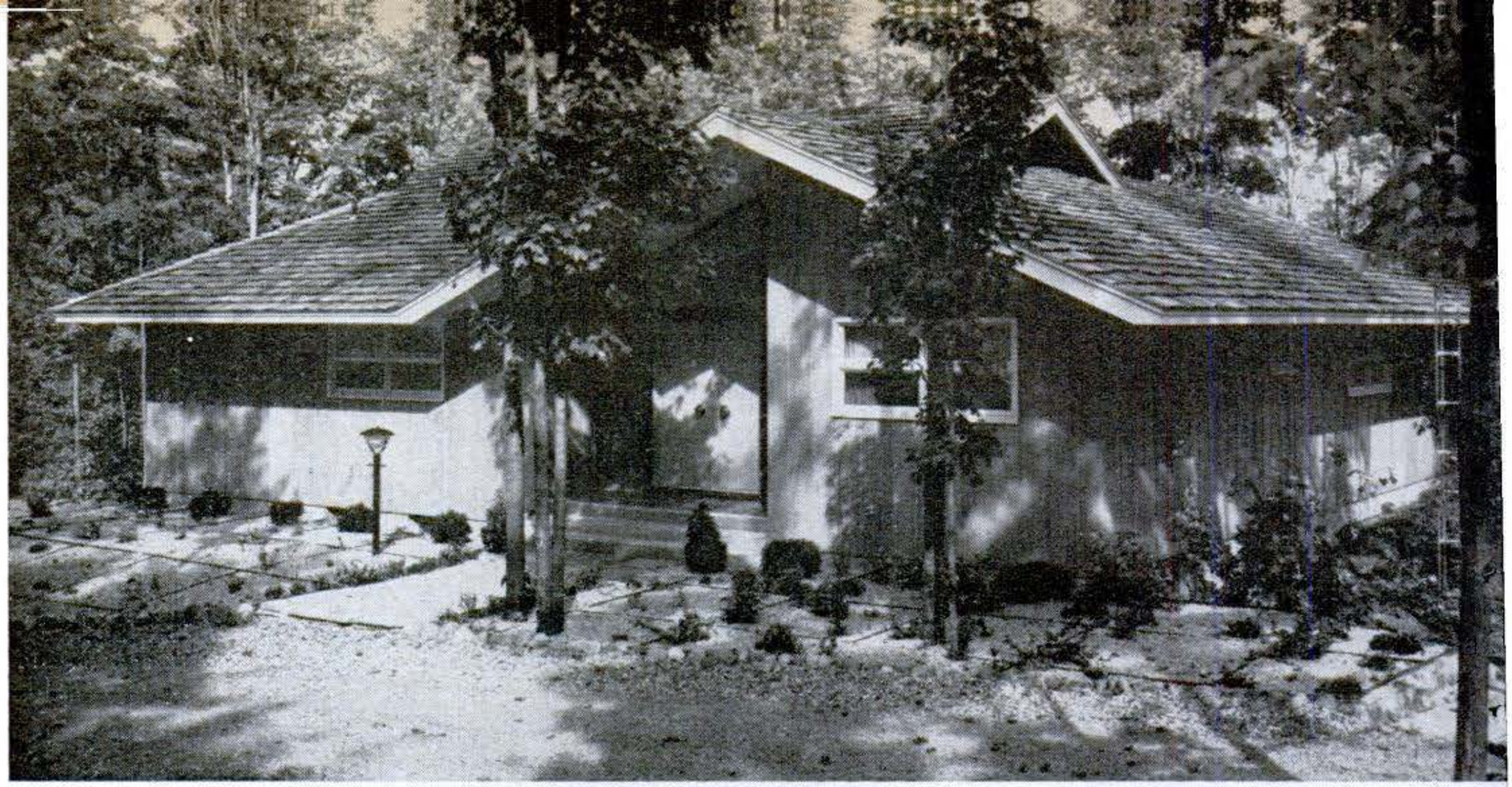


Biggest factor in the new look in houses is plywood siding such as this Early American reverse-batten cedar by U.S. Plywood, and another textured and

GUIDE TO HOME-IMPROVEMENT MATERIALS

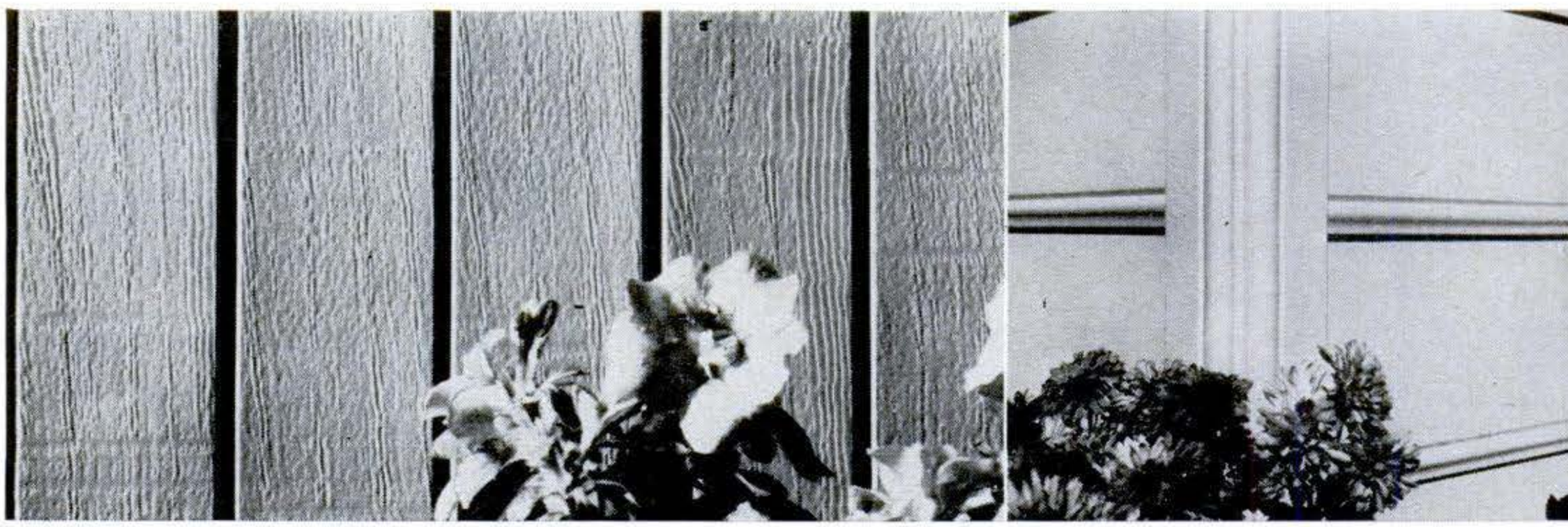
The New Look in HOUSE

By JACKSON HAND

They aren't building houses the way they used to—and it takes only a quick glance at some of the newest, best-thought-out houses going up these days to see the biggest reason why. It's siding.

Siding is taking different forms that save you money, time, and upkeep. Here are some of the ideas showing up more and more often:

- Siding in sheet form is coming on so fast it may take over entirely. What sense does it make to nail up a bundle of boards when you can nail up a single sheet faster and get a more weatherproof wall?
- Siding in strip form, fabricated from such materials as plywood and hardboard, has far greater dimensional stability than wood—shrinks and swells less with weather changes, and can be used in wider forms. Why settle for the old-fashioned look of narrow siding on a modern house when you can use reconstituted wood sid-



Many forms of wood siding are duplicated in aluminum. Here, in order, are Kaiser's rough-sawn,

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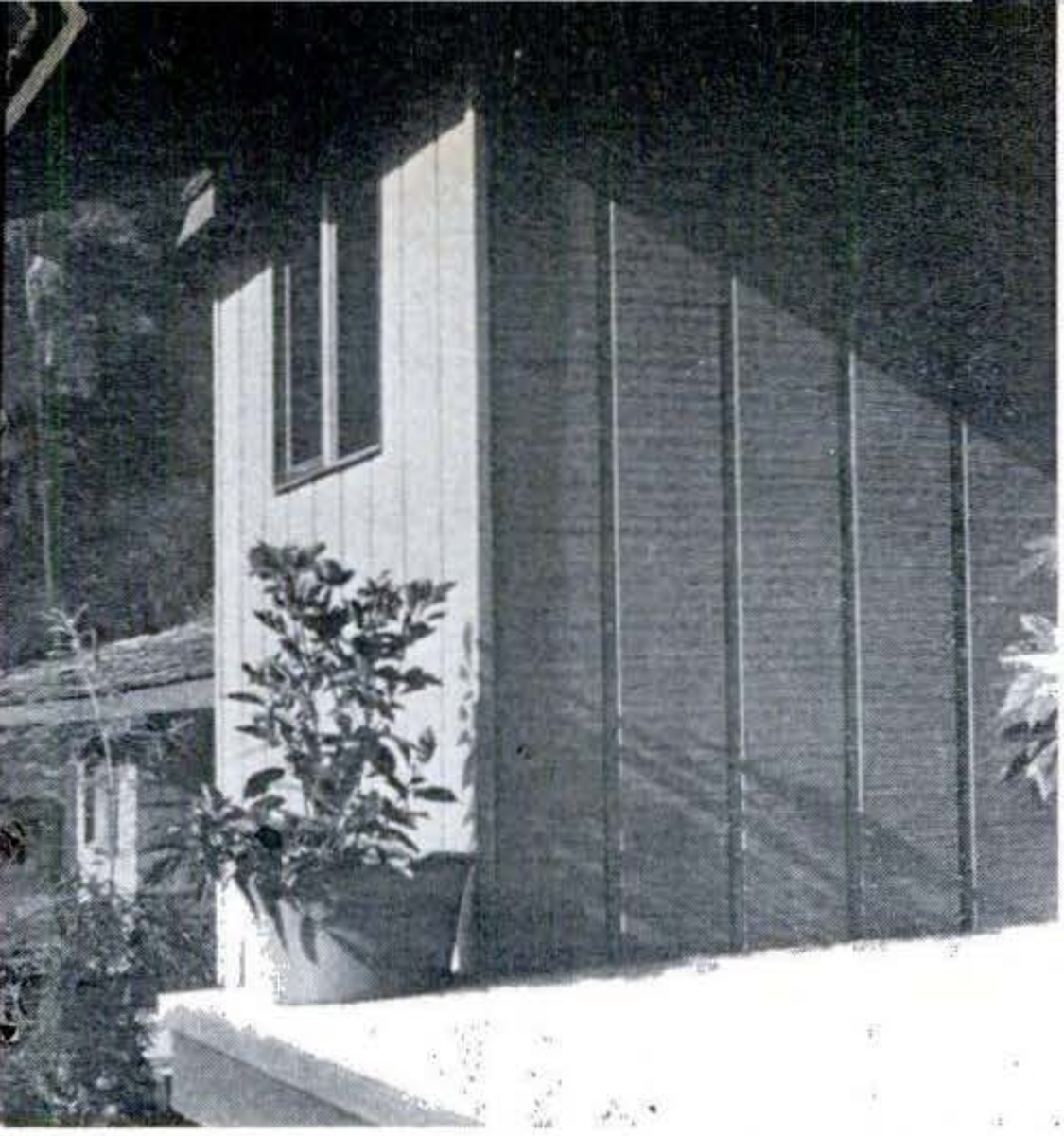
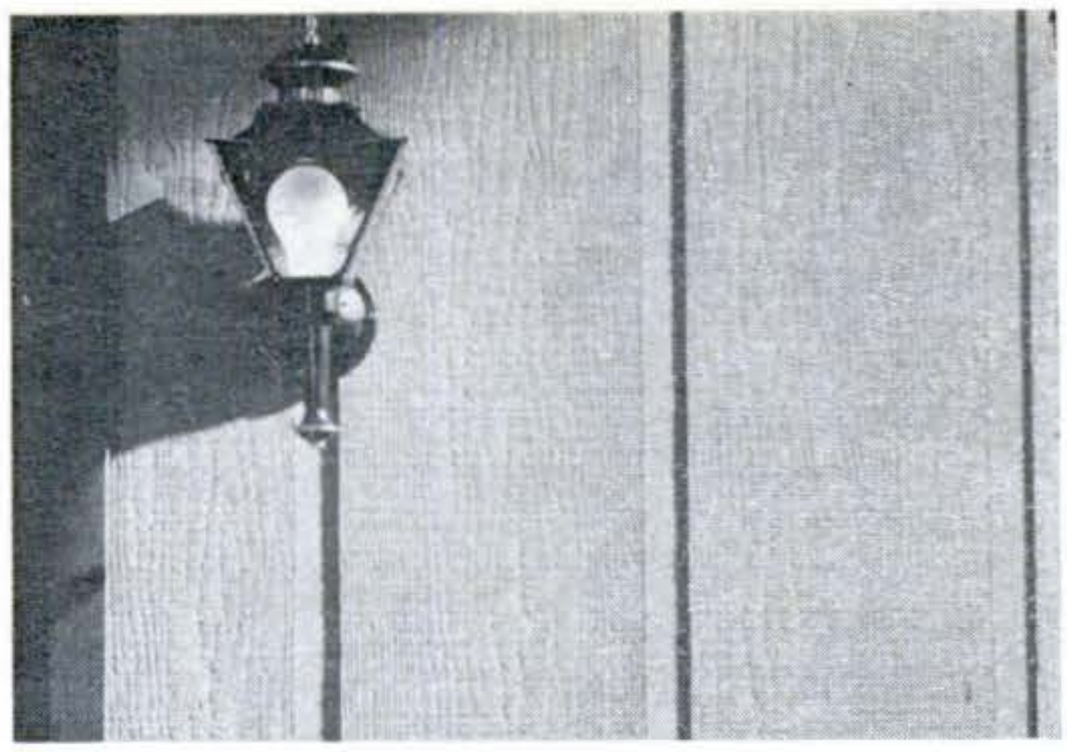
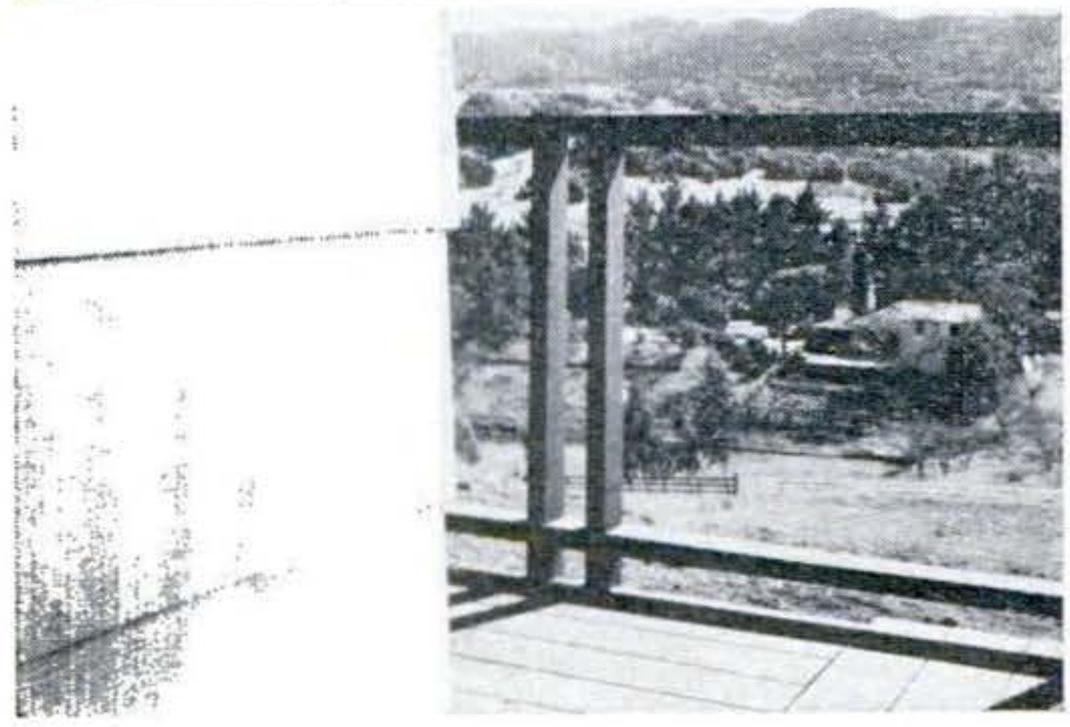


grooved plywood in Philippine mahogany (above) by Boise Cascade. Sheet-form sidings cut costs, sometimes going over studs with no need for sheathing.





SIDING

ing with a reveal up to 12 inches or more?

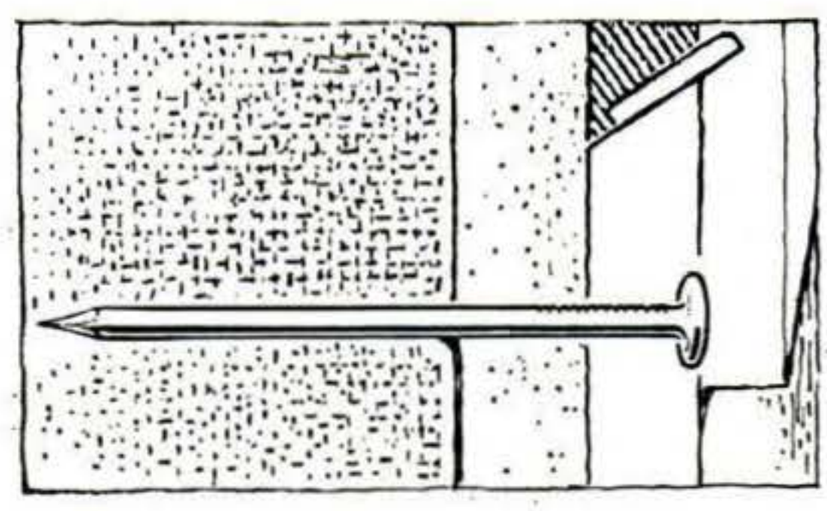
• Siding that already has a finish or is at least primed—or may need no finish at all—is available in most common forms. Why paint a house if you can buy the exterior prepainted?

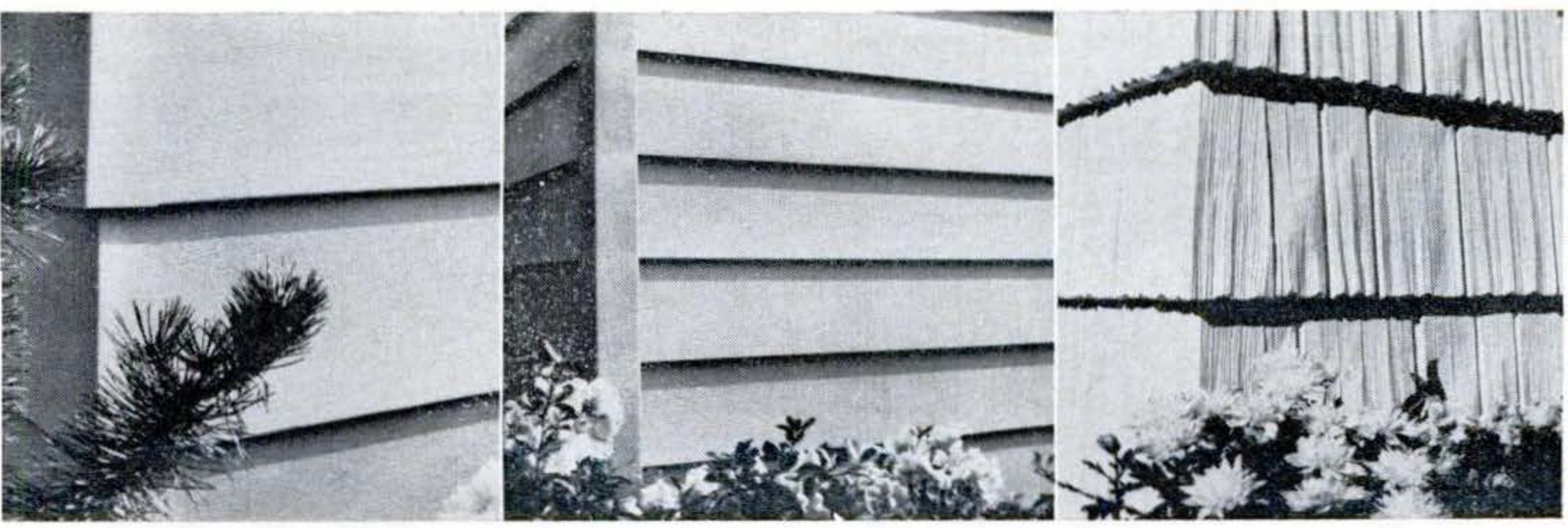
• Most important, siding that goes up in different ways offers you some choice in what the place will look like. Why settle for horizontal stripes when vertical design may offer the difference between the commonplace and the distinctive?

Not all the "newness" about sidings

Continued

Hardboard comes in grooved panels or in strip form, as in Masonite's textured Ruf-X-90 types, above. Hardboard is easy to machine-form in shapes as at right, providing a drip cap and a bigger shadow line. Another feature is a spline in the back (below) that hooks on lower strip, making installation easier.





Sculptured, beveled siding in two widths, and Rustic Shingle. All are guaranteed up [illegible] 20 years.

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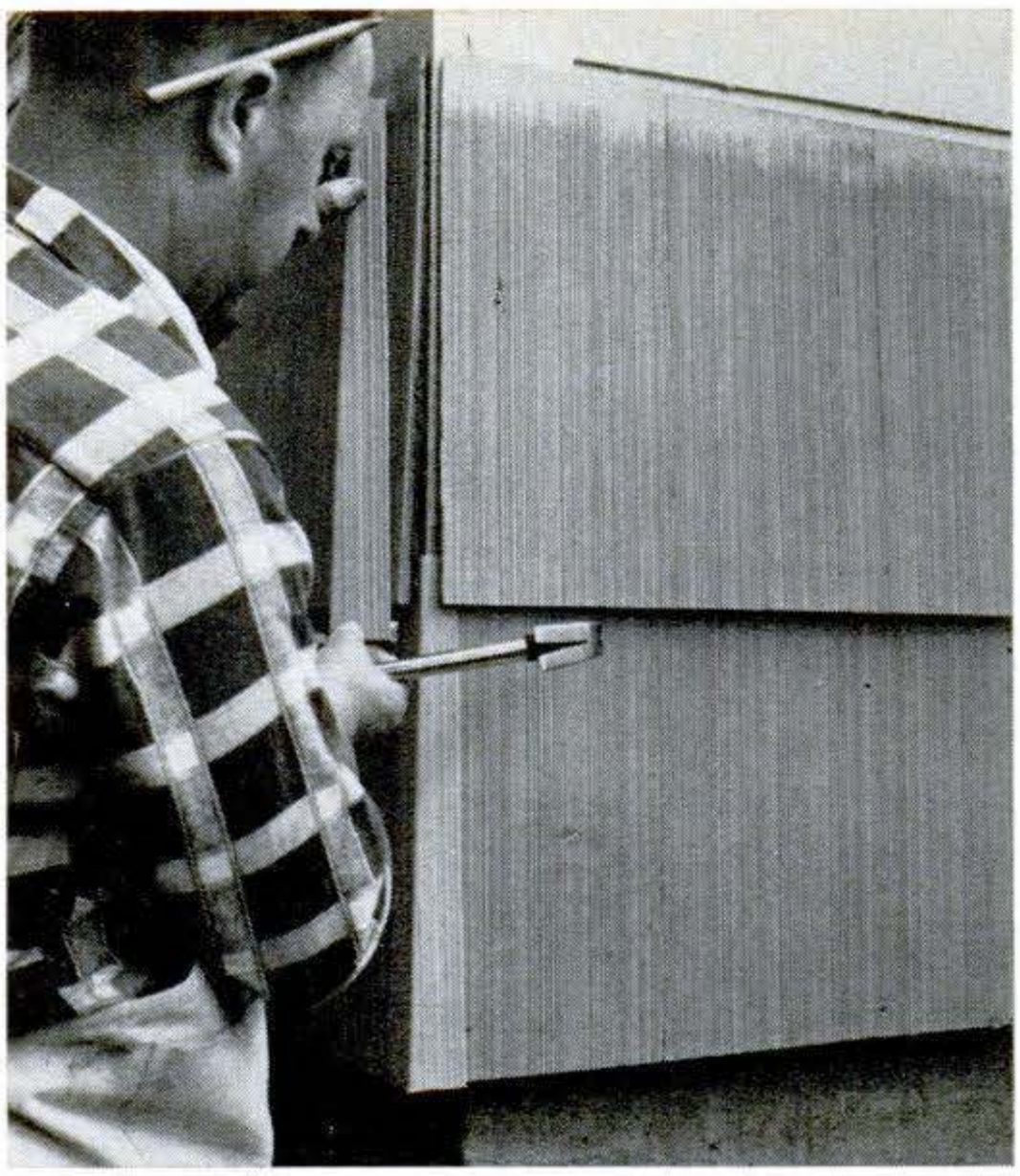

Real wood shakes used as siding no longer present a fitting problem at the corners. The Shakertown Corp. furnishes the matching corner pieces shown.

is genuinely new; much of it is new thinking. About 20 years ago I ran across a fellow in Iowa who had covered the entire outside of his house with asbestos board, handled with vertical battens every 24 inches. The battens were cedar. I asked him what color he planned to paint it, and all he gave me was a puzzled look. I saw the house again last summer. Never had a drop of paint on it, and still looked great.

Much of that sort of thinking is going on today, not only with asbestos board (they're still using it) but with other sheet materials, as well.

Sheet siding. This siding comes four feet wide and in lengths up to 16 feet, depending on materials and locality. You use sheets in the lengths that require the fewest cuts and fewest joints. The obvious advantage is a skin for your house with openings for the weather kept to a minimum.

Plywood siding started with fir—and the inevitable checking and finish failure you'd expect. Then they began to leave the surface unsanded, to deliberately texture it—finally to give it V grooves and square-bottom grooves.

Today there are extremely attractive rough sidings, mainly in cedar, redwood, and Philippine mahogany plywood. These are grooved in what is called "reverse board-and-batten" for vertical installation. One is abraded or sandblasted or otherwise treated to emphasize the grain texture of the wood. Another is given the look of rough-sawn lumber in a special chain-sawing operation. These woods lend themselves particularly well to clear or lightly pigmented finishes; you can have a natural-wood house that stays looking like natural wood.

Hardboard, too, is available in most of the common wood-grain and rough-sawn textures, as well as several patterns not found in plywood. When hardboard is V-grooved or square-grooved, the accents are not usually as deep as in plywood since the material is thinner. Hardboard sheets are not normally intended for unfinished use. They come either primed or finished in house-paint colors.

Makers of aluminum and galvanized siding also have recognized the need for

Rigid nature of mineral-fiber strip siding makes it secure with nailing at top only, as you see in National Gypsum's Woodrock below. Being installed at left is Johns-Manville's unitized 24-inch shingles.

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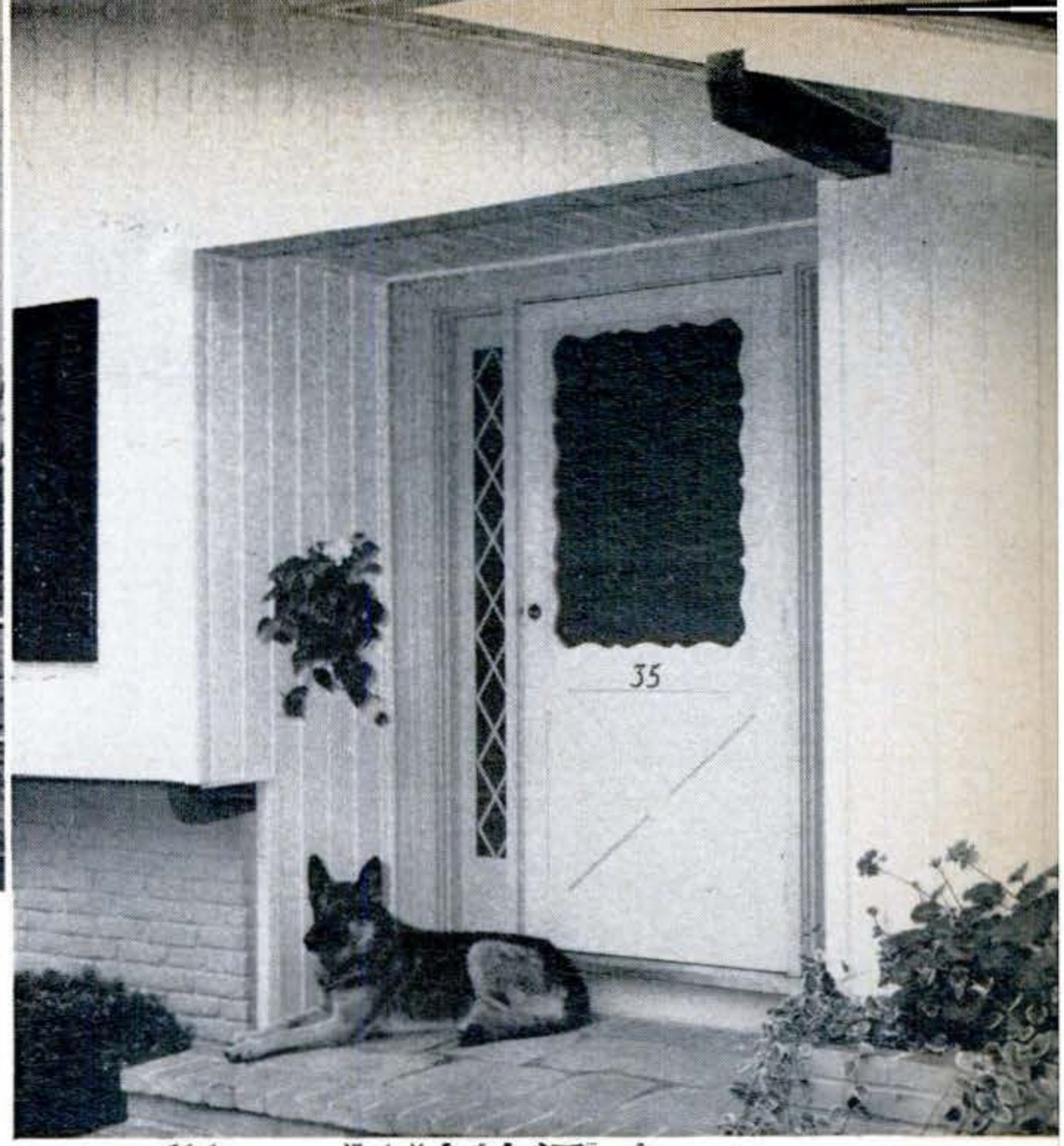
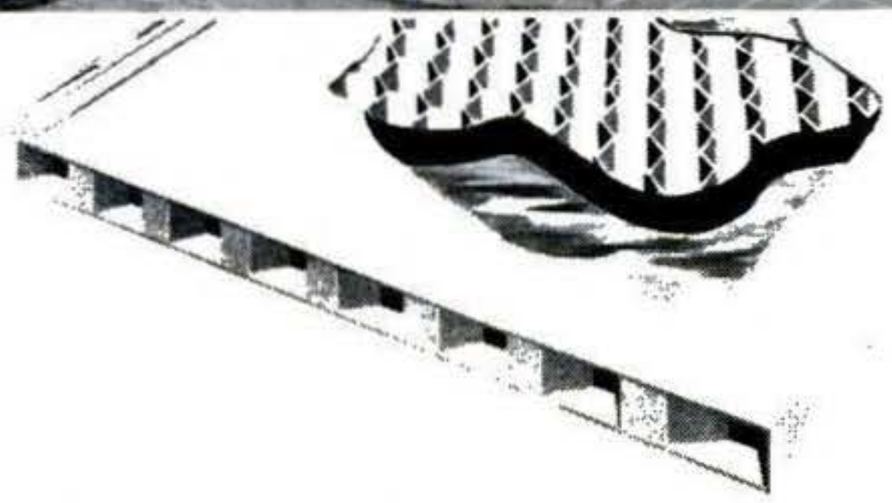


Vinyl is among siding materials you should consider. It now comes in smart vertical grooves or board-and-batten (above and right, Bird & Sons). You can also get it in conventional horizontal strips. A new idea, too, is a honeycomb backing for vinyl offered by U.S. Aluminum & Chemical, right, below.



forms that don't merely emulate beveled siding. Some textured patterns are available, usually in 12- or 16-inch widths.

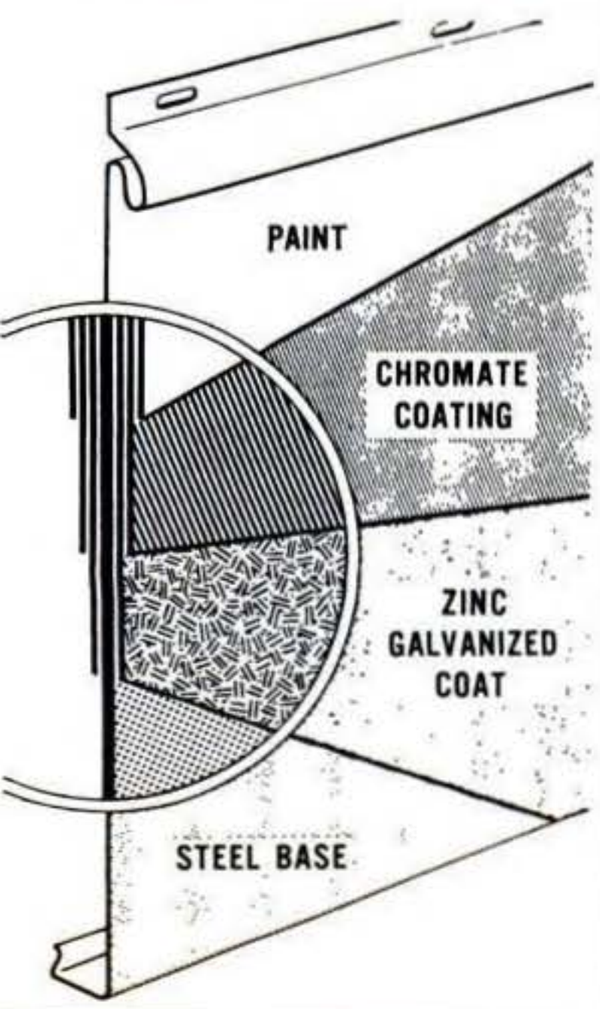
Prefinished siding in panels. Mills turn out sheet-form siding in redwood, cedar, and other woods, prefinished with nothing more than a colorless wood preservative such as pentachlorophenol. This material repels moisture, helps control swelling and shrinking, and lets wood age naturally to a silver gray.

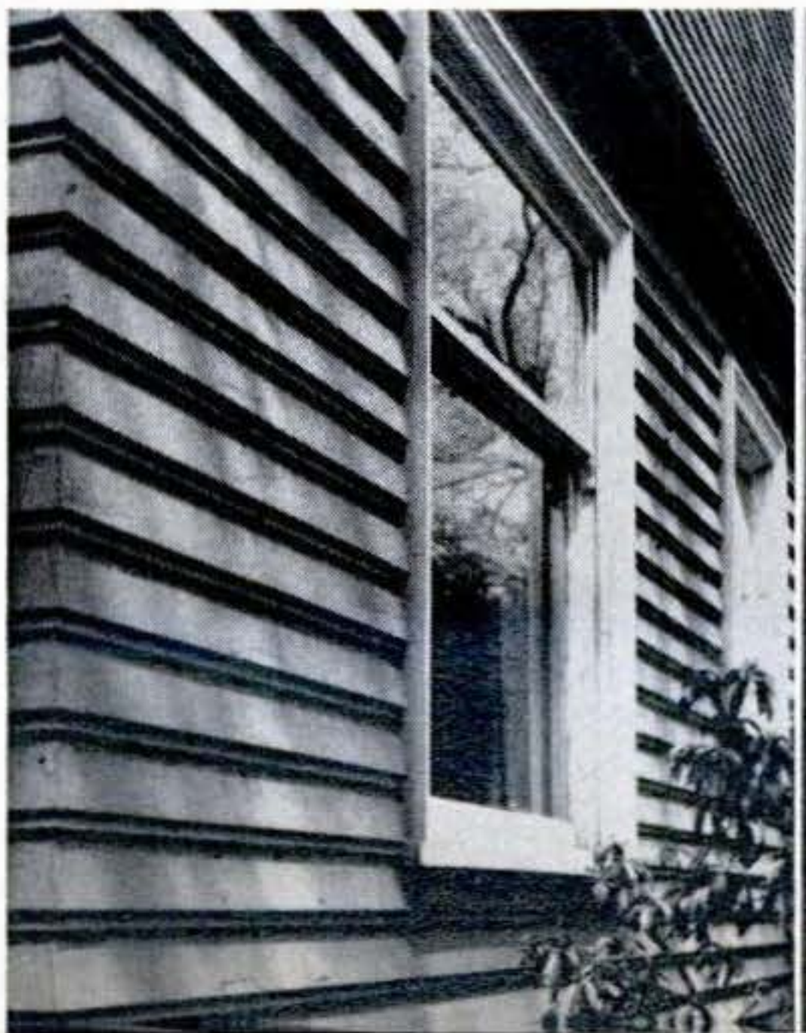
Other wood-siding panels come in most of the semitransparent stain finishes such as Rez or Cabot's stains. These tend to keep the wood from changing color, since they filter out the ultraviolet and other actinic rays of the sun. As a result, pale, woodsy-looking greens and blues hold their colors well.

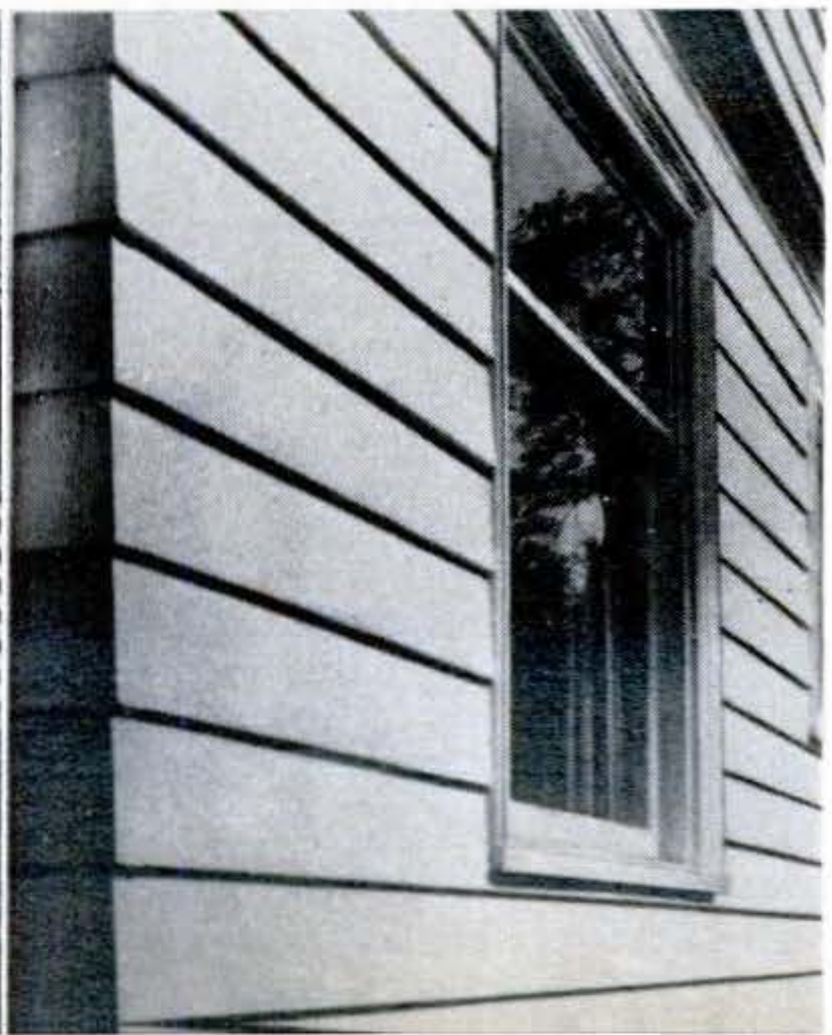
Hardboard panels for exterior use are being made in generally the same textures as those in plywood. There are grain textures, rough-sawn, striated board-and-batten, and several novelty

Continued

Galvanized sheet is growing in importance as a prefinished re-siding material, with the advantages of greater strength, less reaction to temperature changes. Key to galvanized success was introduction of the chromate primer shown in cutaway drawing. Before-and-after results are from U.S. Steel.







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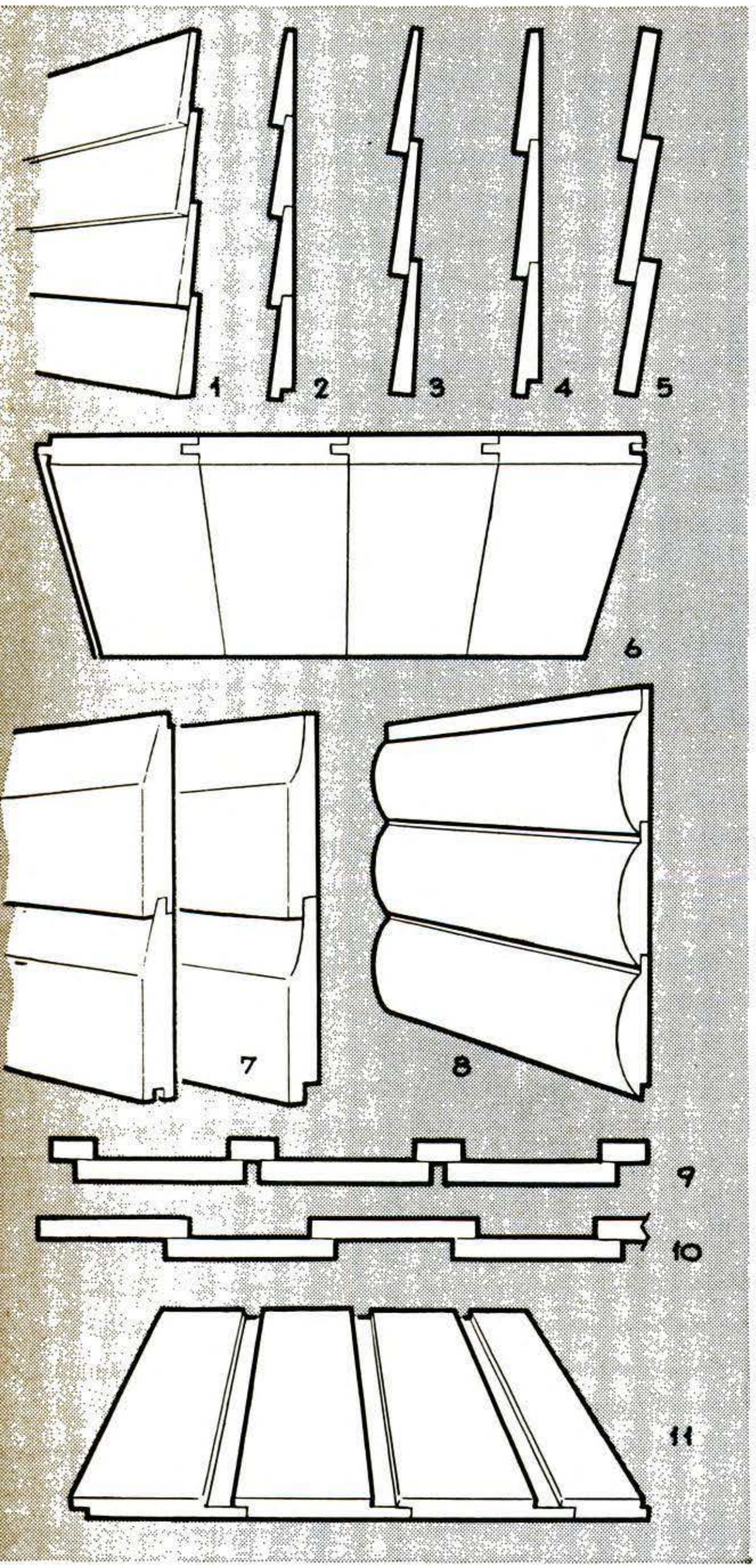
The many forms in which you can buy conventional wood house siding



Regular wood-strip siding now includes these forms: 1) standard; 2) bevel-with-rabbet; 3) thicker bungalow; 4) extra-thick Dolly Varden for heavier shadow-line; 5) square board used as clapboard; 6) tongue-and-groove used horizontally, vertically, or diagonally in some striking new versions; 7) drop siding; 8) log cabin; 9) board-and-batten; 10) board-on-board; 11) a version of shiplap with extra-wide tongue, giving modern wide-groove look. Many of these come in rough-sawn faces, in a variety of woods.

grooves and stripes. These come prefinished in a good range of colors.

Sheet-form asbestos board goes on many commercial buildings, but it is also widely used on homes. It provides a surface much like stucco in appearance, over which the half-beams of English-style architecture can be used. Battens also can be applied over it. The material's coefficient of expansion is very low.

Strip siding. Although the trends in strip siding are not as exciting as they are in sheet siding, there are things worth looking into.

- Hardboard and plywood. Unhampered by the restrictions of board width, siding made of plywood or hardboard has many advantages close to those of panel materials. The strips may be a foot or more in width. It takes fewer of them to cover a house. Installation costs are lower and the job goes faster.
- Asbestos board. Long, wide strips provide an excellent, weather-resistant siding with no finish, and can be painted readily. Quite often, asbestos board is "bulked up" beyond its ordinary thin, high-density form. Vegetable fibers may be used for this purpose, with little or no reduction in weatherproofness.
- Plastic. Vinyl siding, generally in the same forms as wood, is growing in use in residential construction. It is made of colored plastic, is naturally "painted" for as long as it lasts, and should never need repainting except to change color.
- Galvanized siding. Sheet steel—galvanized, primed, and painted—has been available for the home market for only three or four years. Generally, it takes the same forms as the long-established aluminum materials, claiming greater strength and excellent shape retention.
- Solid wood. With the trend all toward something other than horizontal stripes of the kind you get with beveled siding, solid wood is taking two directions. There is an increased use of old ideas, such as board-and-batten and good old-fashioned drop or cove siding. Also, there is a movement toward vertical grooving achieved by "channel" forms and perfectly smooth-surfaced tongue-and-groove, laid horizontally or vertically—or, in some stark modern applications, at an angle on the side of the house.

[Continued on page 205]

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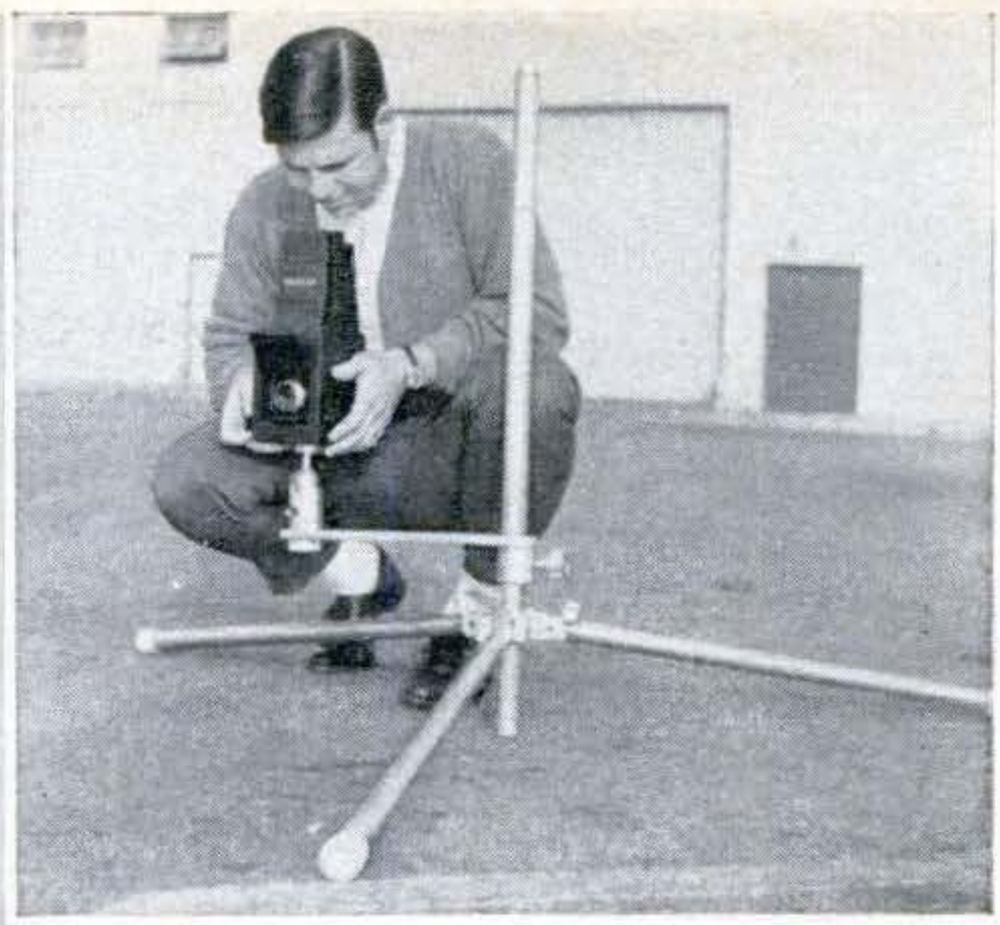

The tall and short of it: With legs fully extended (left), the tripod lets you shoot bird's-eye-view pictures at a height of seven feet. Flat-out (above), the legs are rigidly locked because they rest on center pole. Result: Tripod holds heavy camera securely for low angle shots.

How to make A BETTER TRIPOD than you can buy

By NORMAN FRIED

Photo shops don't have one like it. It can't be bought. But spend a few evenings in your shop, and you can build a tripod that:

- Holds a camera at any angle—high or low.
- Is strong enough to heft press and movie cameras, yet still folds compactly for carrying.
- Has a multiswing boom arm that reaches over and under obstructions for close-ups, copying, and technical photography.

Continued

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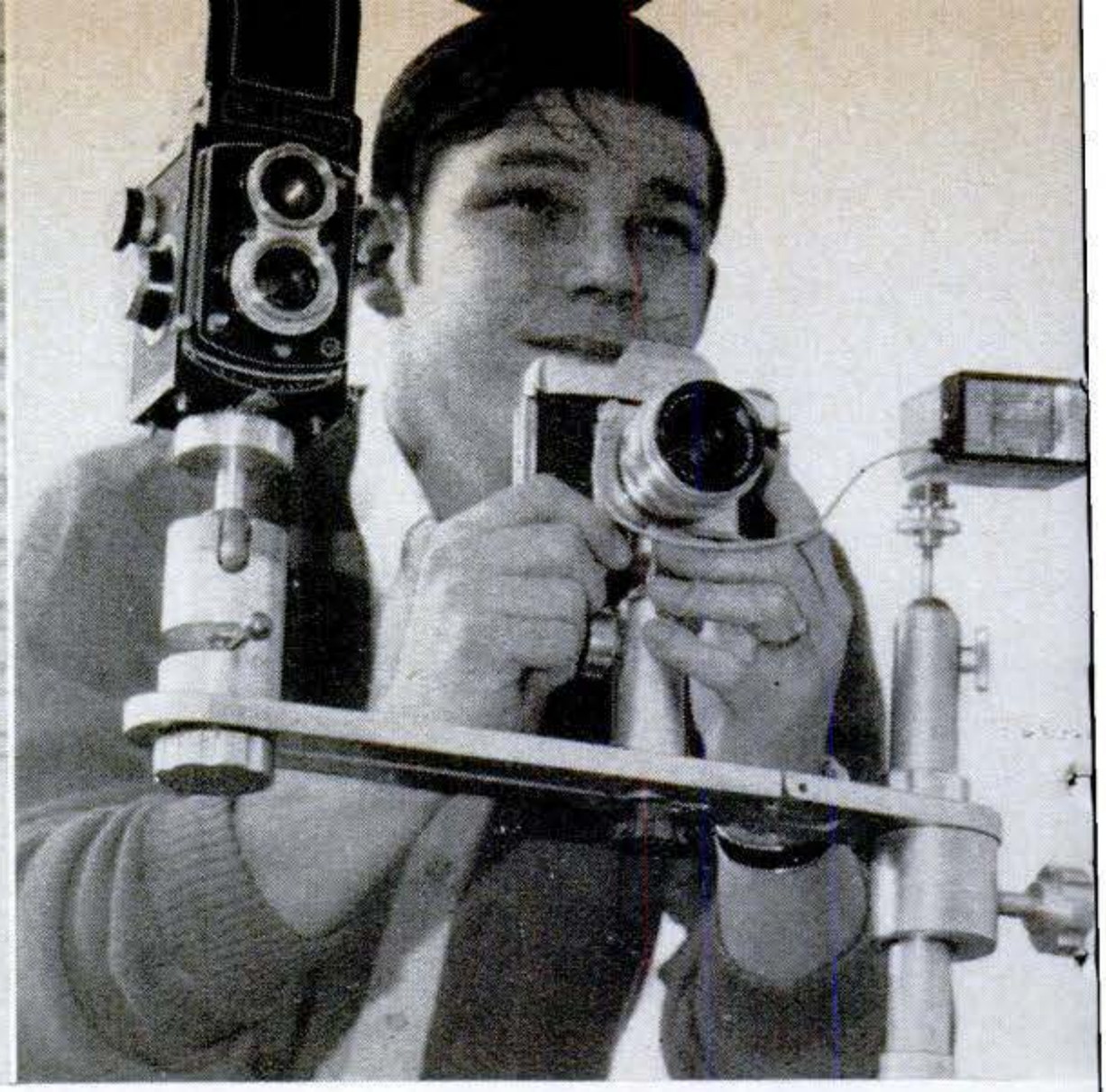
Upside down on boom, press-type camera shoots into the sun, with camera bed acting as long lens shade.



Shooting color and black and white: Boom arm holds two cameras and a strobe for greater flexibility.

The Materials You'll Need

Legs (3)—1¼" O.D. by .065" wall thickness by 28"-long aluminum-alloy tubing (6061 T-6 is good)

Leg plugs (3)—1¼" O.D. by 4" alum.-alloy bar

Leg locks (3)—¾" by 1" by 3⅝" alum.-alloy plate

Leg-lock screws (3)—⅜"-16 by 2"-long steel threaded rod

Leg-lock rollpins (3)—3/16" dia. by ¾" long

Leg washers (6)—⅜" flat steel washers

Preload screws (3)—⅜"-16 by 1¼" steel F.H. screws

Leg stops (3)—¼"-20 by 1" knurled thumb screws

Boom lock (1)—¼"-20 by 1" knurled thumb screw

Leg pivots (3)—½"-dia. by ⅛" wall by 2½"-long steel tubing or solid rod

Pivot locks (3)—3/16"-dia. by 1"-long rollpins

Spider (1)—1¼" by 5" by 6" alum.-alloy plate

Center post (1)—1⅜"-O.D. by ⅛"-wall by 34" alum.-alloy tubing

Lock knobs (4)—1¾"-dia. by 1"-long alum. alloy

Sleeves (2)—½"-O.D. by .040"-wall by 2" alum. or steel tubing

Extension center post (1)—1⅛" O.D. by .065" wall by 30"-long alum.-alloy tubing

Post lock shaft (1)—½" O.D. by .040"-wall by 31"-long steel or brass tubing

Extension center-post collar (1)—1⅜"-O.D. by 2⅛"-long alum.-alloy tubing

Lock cams (2)—1"-O.D. by ¾"-long nylon rod

Boom sleeve (1)—2¼"-O.D. by 2⅛"-long alum. alloy

Boom (1)—½" by 2¼" by 16"-long alum.-alloy plate

Boom pivot (1)—3/16"-dia. by 2"-long rollpin

Boom screws (3)—¼"-20 by 1½"-long F.H. screws

Boom pins (1)—⅛"-dia. by 1"-long rollpins; (2)—⅛"-dia. by ¼"-long rollpins

• Has rigid legs that aren't damaged by sand or weather.

A metal lathe, bandsaw, sander, and drill press are the major tools needed for the project. But, lacking the necessary tools (or skills) to build the tripod, you can "job out" the machining of parts inexpensively to a local machine shop. (The Lie-Flat Blueprint on the following pages gives the drawings needed to machine the parts.)

Where to start. Since no castings are required, start by cutting all tubing to length. Cut the parts about 1/16" oversize to allow for facing off and deburring. Next, cut the leg plugs and turn down the shank so that the end plugs slide easily into the tubing legs with .002" to .006" to spare for adhesive.

Drill the holes for the leg pivot, preload screw, and lock knob. To insure accurate size and finish on the pivot hole, do the drilling in three stages. Start with an ⅛" bit, enlarge the hole with a 15/32" drill, and finish with a ½"-diameter reamer (or, drill—feeding slowly with korosene as a coolant).

Make the saw kerf in the leg plug about ⅛" wide and smooth the inside surfaces of the cut with a file or a belt sander. Note that the screw-clearance holes stop at the kerf and continue as threaded holes on the other side of the kerf. Using the pivot-sanding jig shown on the blueprint, sand the top of the plug half-round.

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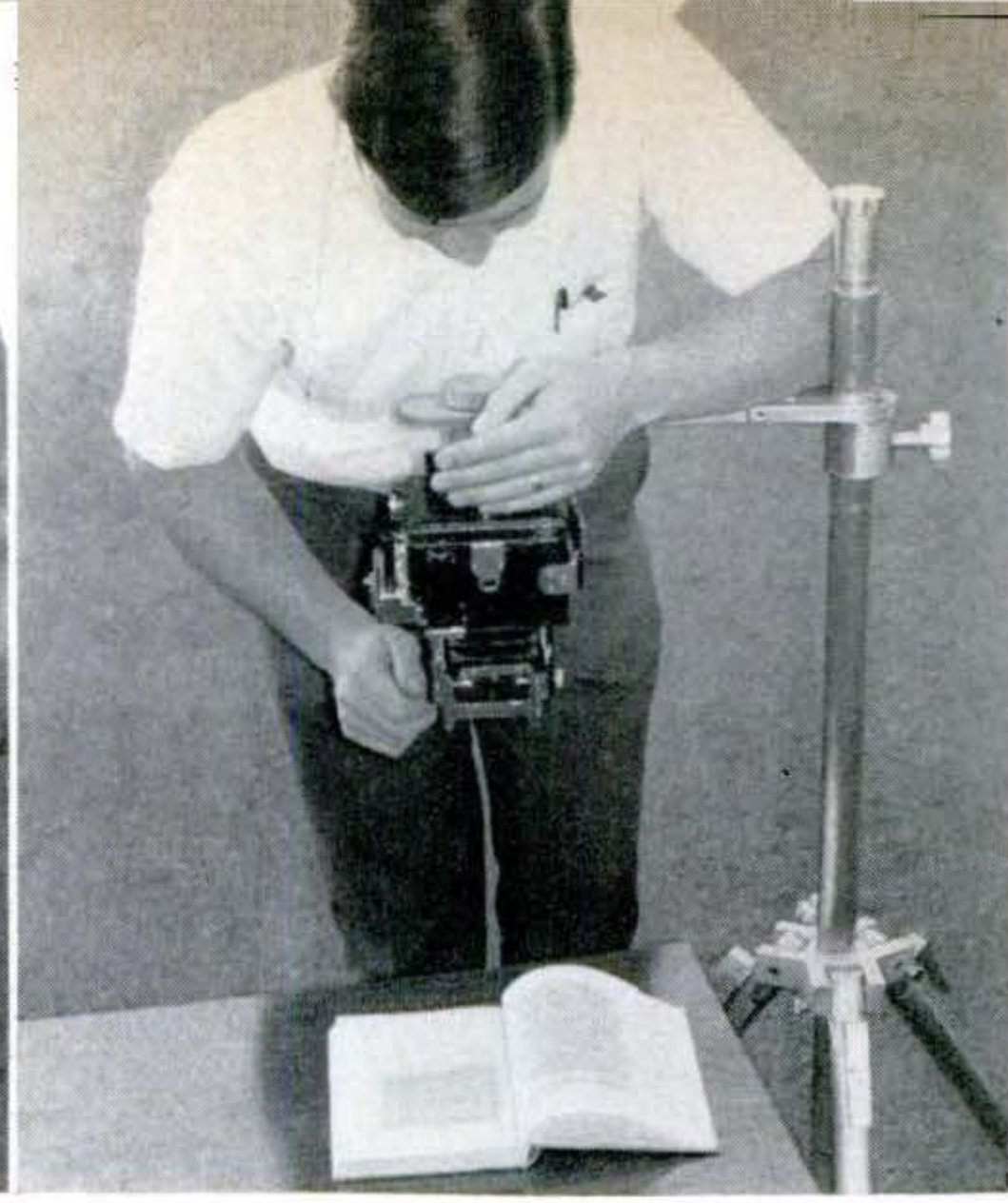
Camera swings over car's engine for technical close-up. For more stability, hang gadget bag from spider.



Mounted on underside of boom, camera with vibration-free cable release provides quick copy setup.

To clean the plug shank and adjoining inside surface of the leg tubes, use a detergent followed by an alcohol or acetone wash. When the parts have dried, fasten them together with epoxy cement or an anerobic adhesive (Loctite, aluminum grade). For easy locking, be sure to keep adhesive out of the saw kerfs.

The spider. After laying out the spider, cut it accurately to the lines on the bandsaw. After finish-sanding all surfaces (rounding off sharp edges and corners), drill ½"-diameter holes for the leg pivots, keeping each pair of holes in line. Drill for the center-post lock knob and leg stops —but don't tap for the leg stops at this time. (They will be used later as spot-drilling guides, and are left untapped to avoid damage to the threads.)

Bore the center hole in the spider so that it makes a sliding fit over the center post. A fine finish on this bore insures smooth, fast height adjustment with the tripod.

Chuck the extension center post in the lathe with half of its length protruding. After sanding the outside diameter to a sliding fit in the center post, finish off with a fine grit (about #400, cloth-backed). Reverse the part in the chuck, and repeat the operation on the other half of the post.

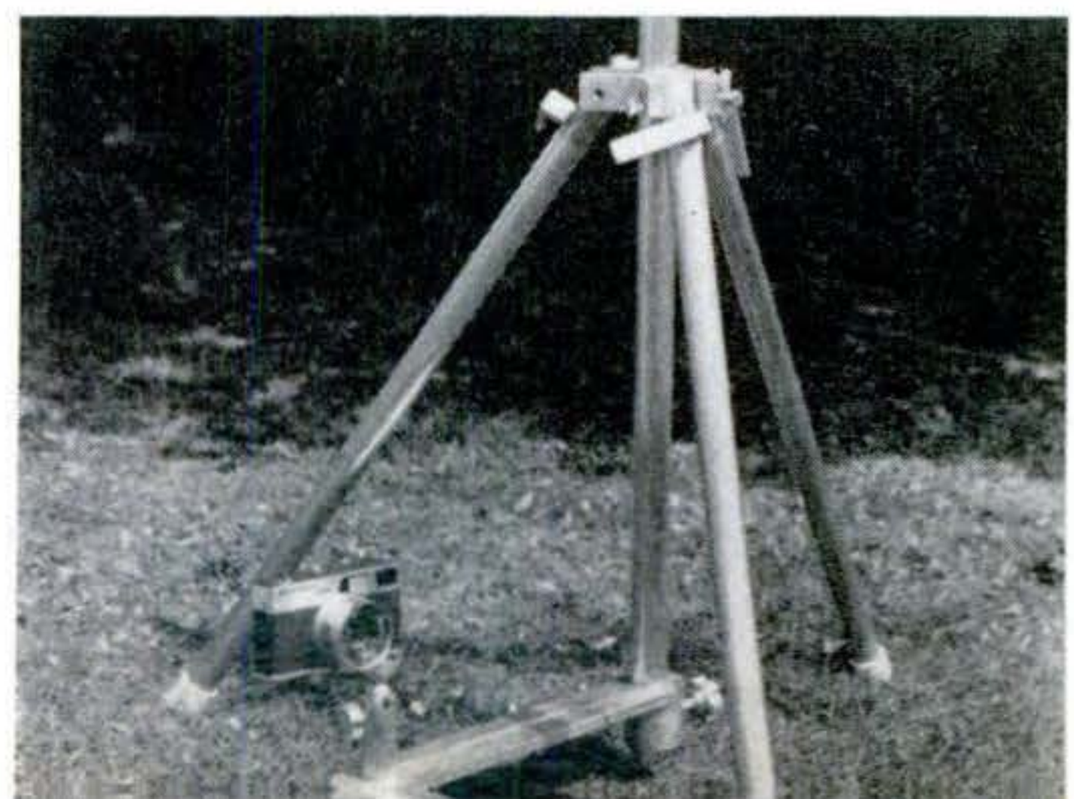
Cut off and face the nylon (or brass) lock cams. Slide the extension-post collar into place and cement, again allowing for

[*Text continued on page 200*]

In tight spots, fold and lock one leg; swing boom close in, leaving room to sight through viewfinder.

Turn the page for lie-flat blueprint

Alternate low-angle camera position requires no leg-locking, permits faster change from high to low.



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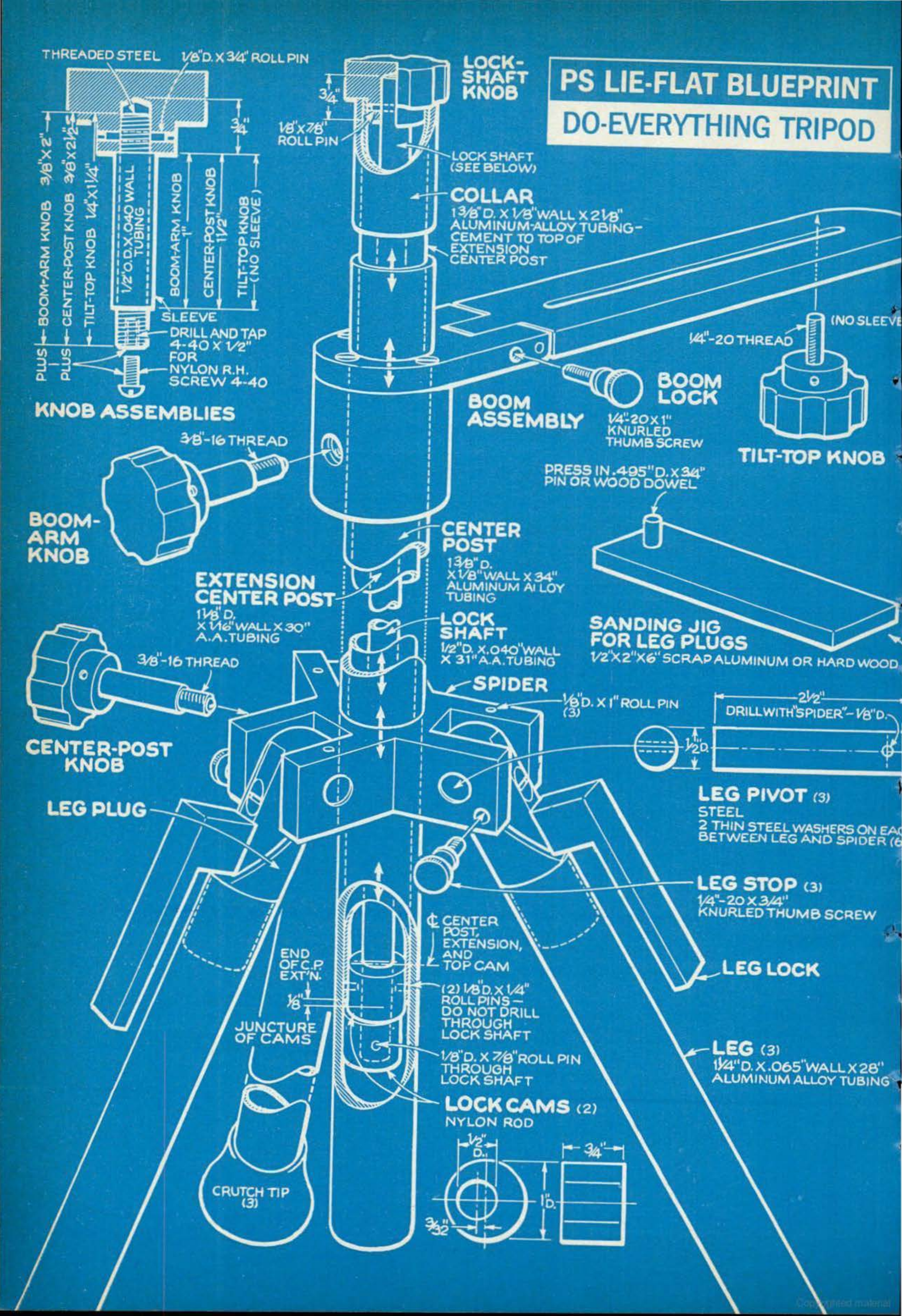
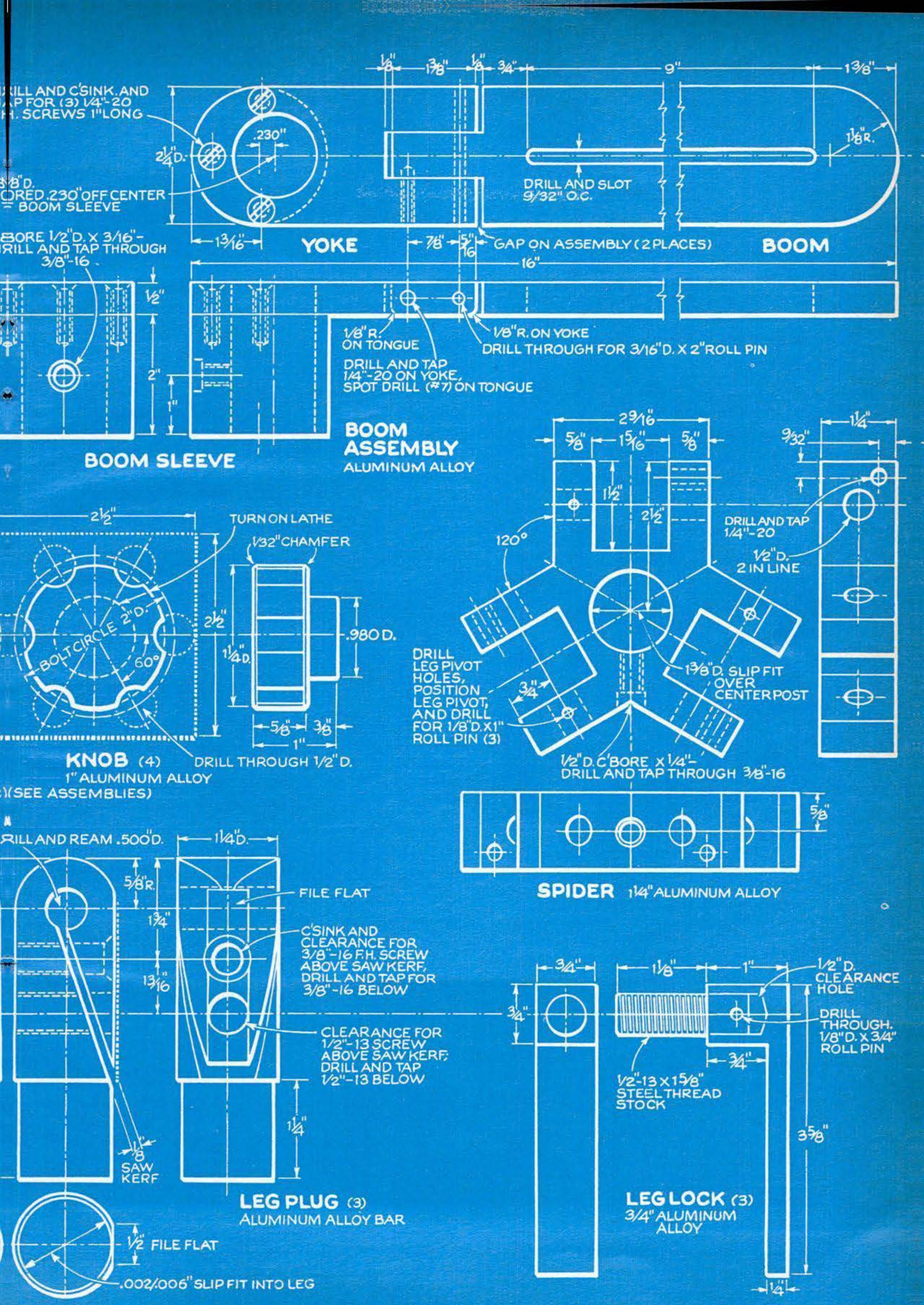
PS LIE-FLAT BLUEPRINT
DO-EVERYTHING TRIPOD




RILL AND C'SINK. AND
AP FOR (3) 1/4"-20
H. SCREWS 1" LONG
3/8" D.
ORED .230" OFF CENTER
= BOOM SLEEVE
BORE 1/2" D. X 3/16" -
RILL AND TAP THROUGH
3/8"-16
1/8"
1 3/8"
1/8"
3/4"
9"
1 3/8"
2 1/4" D.
.230"
1 1/8" R.
DRILL AND SLOT
9/32" O.C.
1 3/16"
YOKE
7/8"
5/16"
GAP ON ASSEMBLY (2 PLACES)
BOOM
16"
1/2"
2"
1"
1/8" R.
ON TONGUE
1/8" R. ON YOKE
DRILL THROUGH FOR 3/16" D. X 2" ROLL PIN
DRILL AND TAP
1/4"-20 ON YOKE,
SPOT DRILL (#7) ON TONGUE
BOOM SLEEVE
BOOM
ASSEMBLY
ALUMINUM ALLOY
2 9/16"
5/8"
1 5/16"
5/8"
1 1/4"
9/32"
1 1/2"
2 1/2"
120°
DRILL AND TAP
1/4"-20
1/2" D.
2 IN LINE
2 1/2"
TURN ON LATHE
1/32" CHAMFER
2" D.
BOLT CIRCLE
60°
2 1/2"
1 1/4" D.
.980 D.
5/8"
3/8"
1"
DRILL THROUGH 1/2" D.
KNOB (4)
1" ALUMINUM ALLOY
(SEE ASSEMBLIES)
DRILL
LEG PIVOT
HOLES,
POSITION
LEG PIVOT,
AND DRILL
FOR 1/8" D. X 1"
ROLL PIN (3)
3/4"
1 3/8" D. SLIP FIT
OVER
CENTER POST
1/2" D. C'BORE X 1/4" -
DRILL AND TAP THROUGH 3/8"-16
5/8"
SPIDER 1 1/4" ALUMINUM ALLOY
RILL AND REAM .500" D.
1 1/4" D.
5/8" R.
FILE FLAT
1 3/4"
C'SINK AND
CLEARANCE FOR
3/8"-16 F.H. SCREW
ABOVE SAW KERF,
DRILL AND TAP FOR
3/8"-16 BELOW
1 3/16"
CLEARANCE FOR
1/2"-13 SCREW
ABOVE SAW KERF;
DRILL AND TAP
1/2"-13 BELOW
1 1/4"
1/8
SAW
KERF
LEG PLUG (3)
ALUMINUM ALLOY BAR
1/2" FILE FLAT
.002/.006" SLIP FIT INTO LEG
3/4"
1 1/8"
1"
1/2" D.
CLEARANCE
HOLE
3/4"
DRILL
THROUGH.
1/8" D. X 3/4"
ROLL PIN
3/4"
1/2"-13 X 1 5/8"
STEEL THREAD
STOCK
3 5/8"
LEG LOCK (3)
3/4" ALUMINUM
ALLOY
1/4"

Spiked Wheel Drives Power Sled

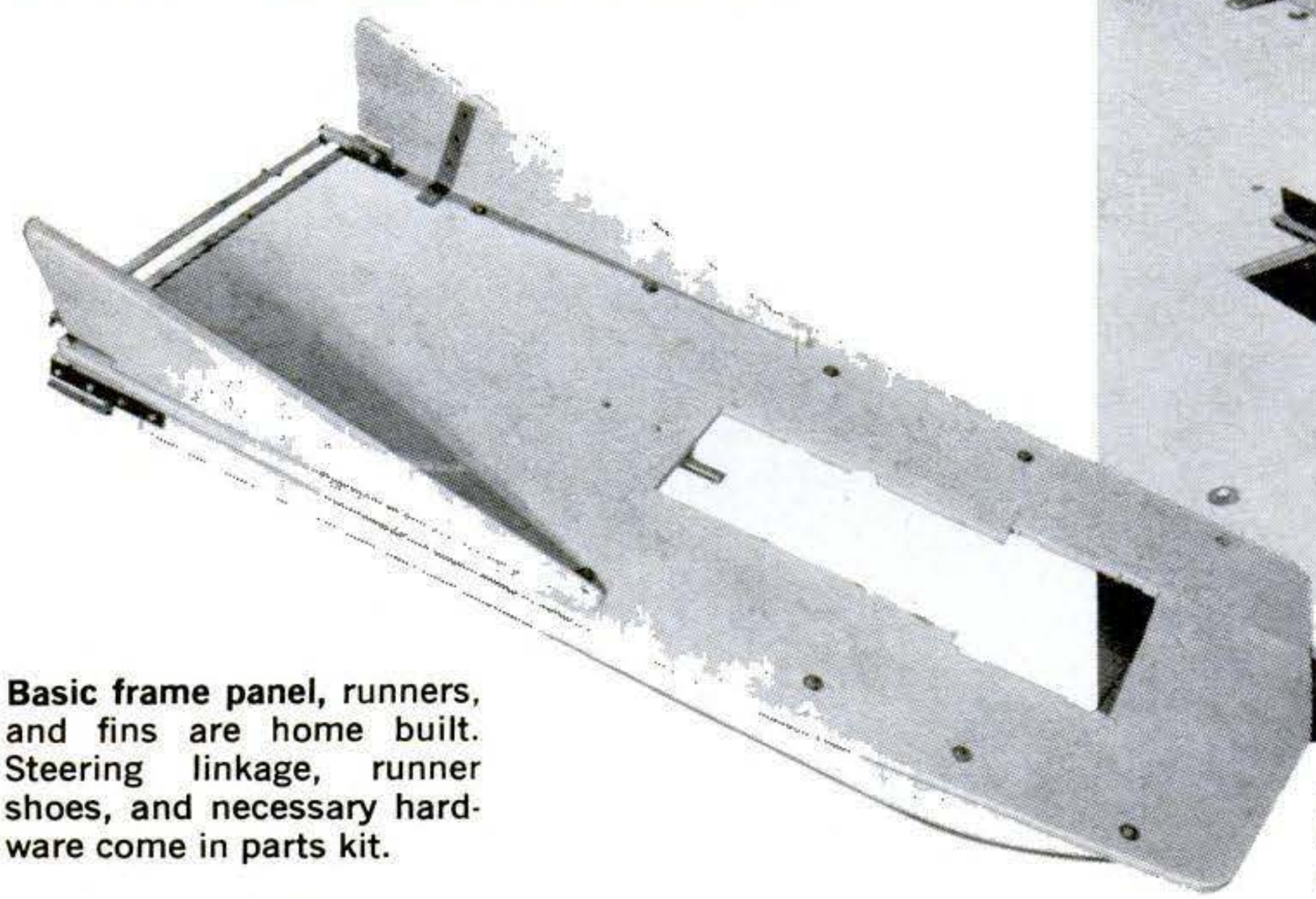
By E. F. LINDSLEY/*PS Outdoor Power Equipment Editor*

Long bolts that hold runner shoe, runner, and deck together must be dressed off. Shoes, ¾ inch wide, come bent and tapped. Drilling the holes accurately is hardest job.

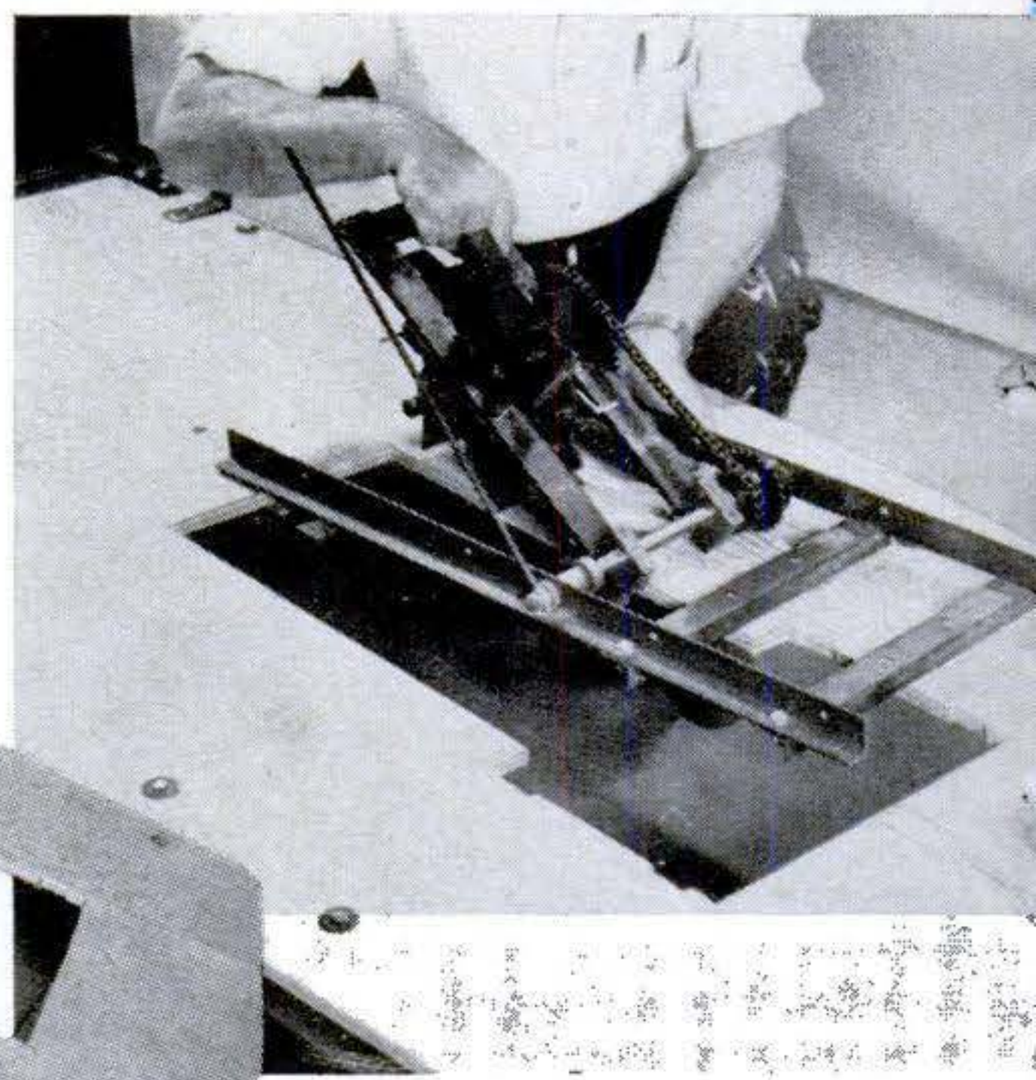
For inexpensive, fast-moving fun, or for getting to those ice-fishing spots, it's hard to beat the Simko power sled. It's not a tread-type snowmobile, but a real sled that rides on runners over ice, packed snow, or any snow firm enough to hold its weight. The sled is driven by a multipronged, spring-loaded wheel that digs into the ice. Power is provided by engines of three to 12 hp. A 12-horse sled can do up to 60 m.p.h. A pair of rear-mounted steering runners gives perfect control on ice for smooth turns or exciting power slides.

The design is simple but sturdy. Sled bodies are of wood or welded tubular steel, and seat one or two riders. You can buy a completely assembled sled—a two-man model of metal with a four-hp. engine—for about $250.

But building your own, using kits of metal parts, is easy. I built a two-man wooden sled from such a kit in about 20 hours. It cost less than $150, including lumber, which doesn't come with the kit. If you wish to do the whole job from scratch, model plans sell for $3 a set. A brochure of various models and kits, and a parts-and-price list are 25 cents each from Simko Power Sleds, 4420 West Jefferson, Ecorse, Mich. 48229.



Basic frame panel, runners, and fins are home built. Steering linkage, runner shoes, and necessary hardware come in parts kit.



Drive device is spring-loaded. Shaft, by author's right arm, raises and lowers spiked disk.

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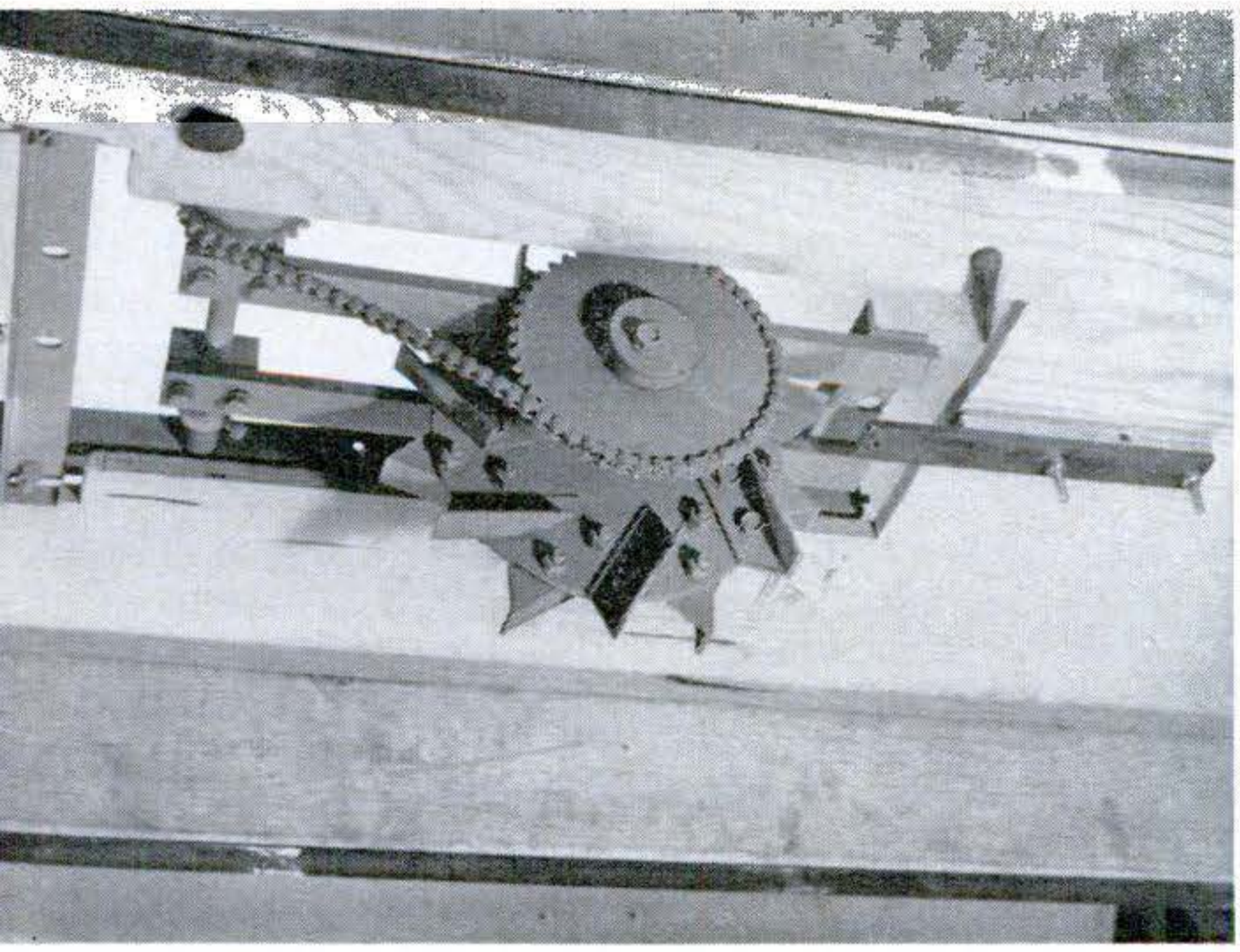
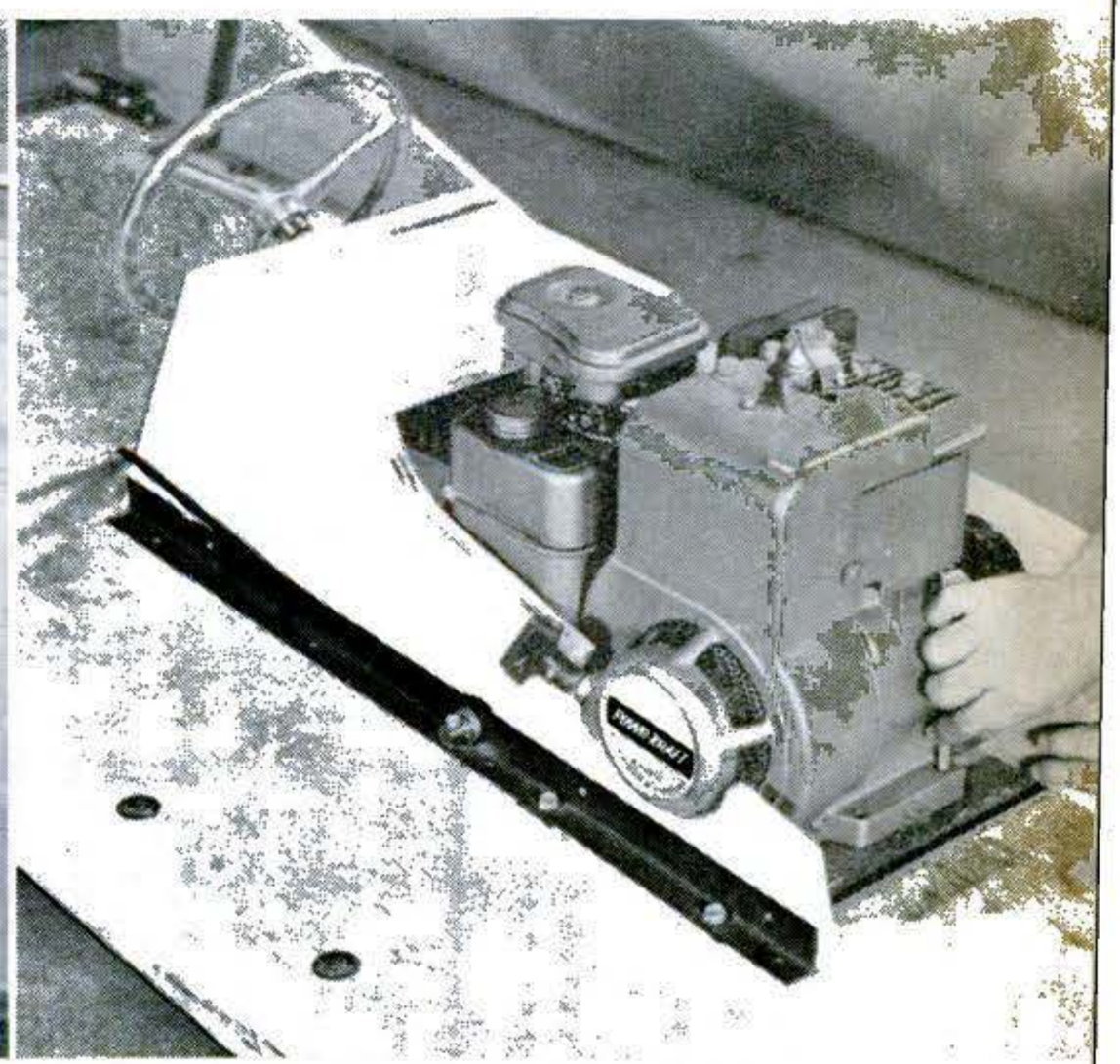
Metal body of this one-man sled is of welded tubular steel. It's available as a kit or assembled. There's also a two-man model.

Two-passenger power sled with wood body can be built for less than $150. Metal parts come in a kit; you buy and cut all lumber. The windshield is optional.



Underside of sled shows the driving wheel, a pronged metal disk mounted in center. It bites in for pulling over ice, snow, or any surface firm enough to hold the sled's weight.



Standard mounts fit Briggs and Stratton engines—others require altered mounts. Clutch is centrifugal.

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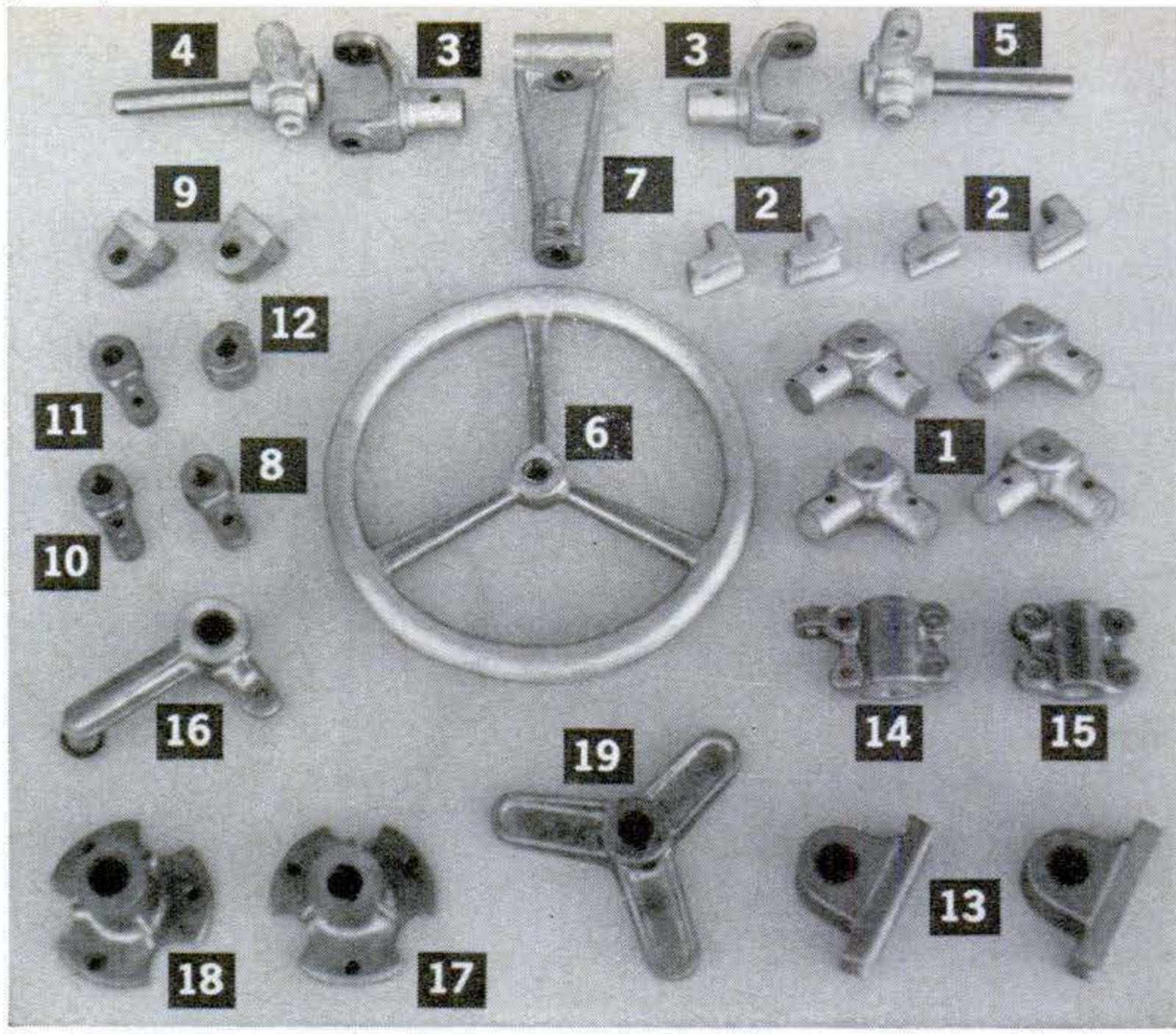
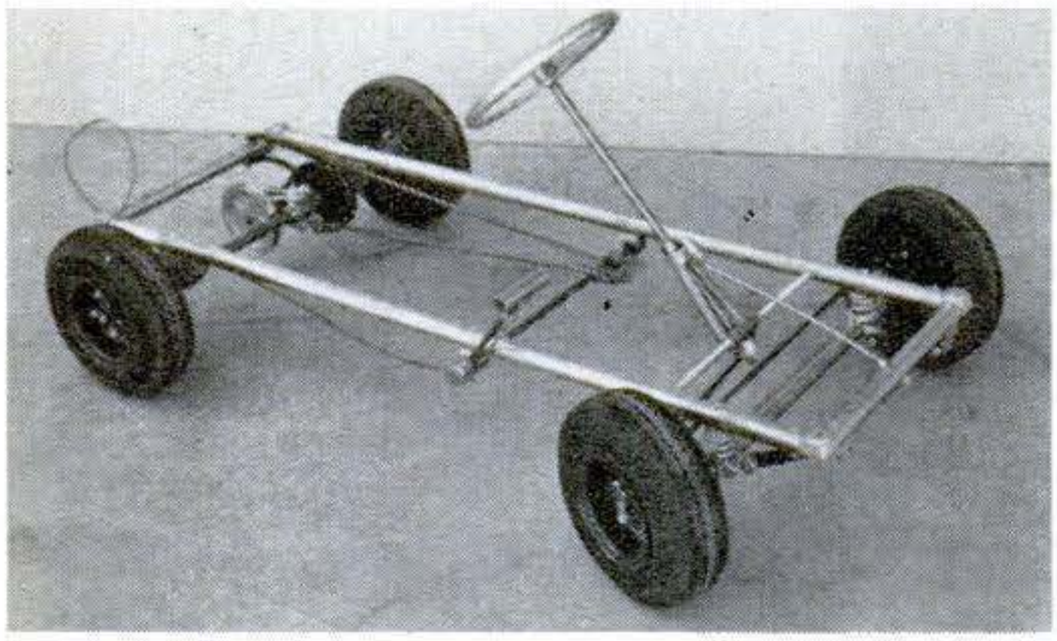
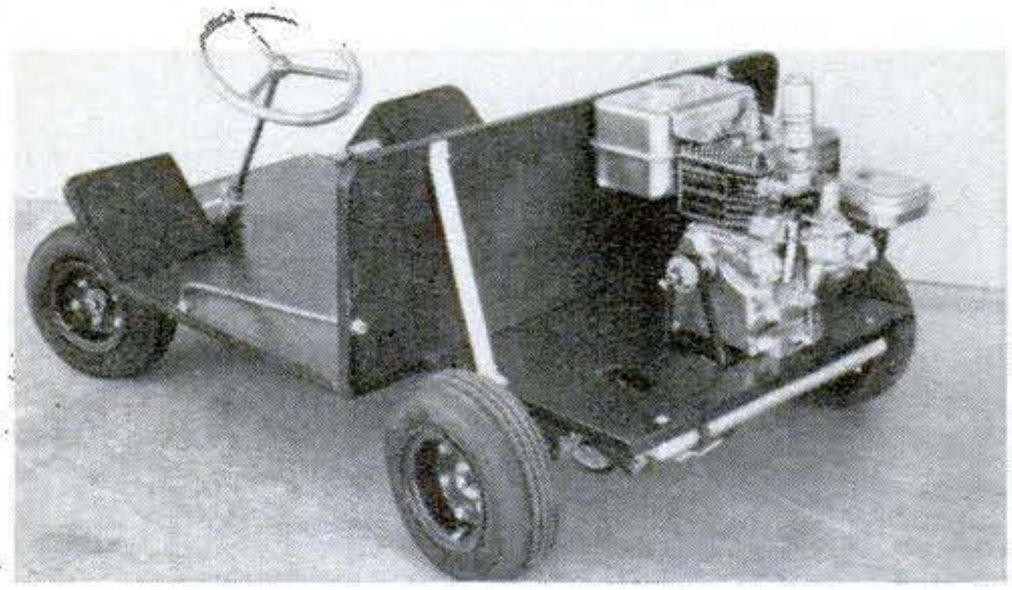


Fittings you can buy to make bolt-together conduit frames are shown at right: 1. frame corner; 2. stabilizer bracket; 3. axle yoke; 4. left-axle spindle; 5. right-axle spindle; 6. 10-inch steering wheel; 7. steering-column bracket; 8. steering arm; 9. control-assembly bracket; 10. brake arm; 11. clutch arm; 12. control-lever casting; 13. rear-axle bearing; 14. bottom-clutch casting; 15. top-clutch casting; 16. rear-axle brake lever; 17. drive hub; 18. rear-axle idler hub; 19. drive adapter. Fittings are sold separately or in a kit with kart plans.

Frame Anything with Conduit ...and These Fittings





One-inch thinwall conduit and the fittings shown at top of page were used to frame this kart. Set of fittings with plans costs $32.25; plans only, $3.50.

Electrical conduit is durable stuff, and now, with these fittings, you can use it to make frames for karts, shelves, or almost anything else you can think of. It's also inexpensive, and available at any electrical-supply house.

The fittings are made for one-inch thinwall conduit. Since the frames are bolted together—no welding—you can assemble them with a minimum of tools.

The manufacturer also offers plans for building small one- and two-passenger karts. A complete chassis kit, including fittings, conduit, hardware, and instructions (but minus wheels, body, and engine), sells for $69. Or you can draw your own designs and use the fittings to build other conduit-framed items, such as lawn tractors, trailers, or shelves.

You can get prices and complete information on the conduit fittings by writing to the Braco Manufacturing Co., Box 26186, Denver, Colo. 80226.

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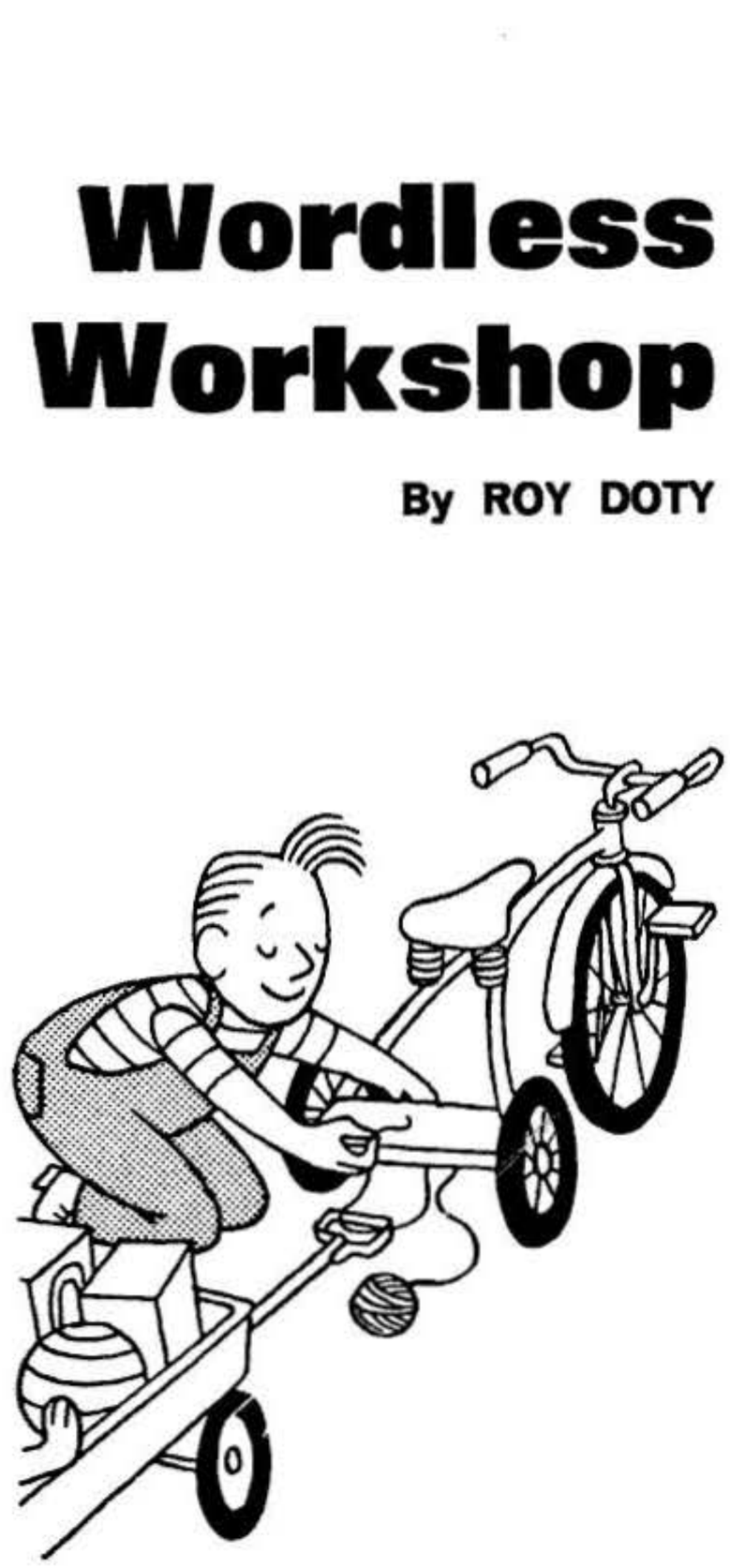
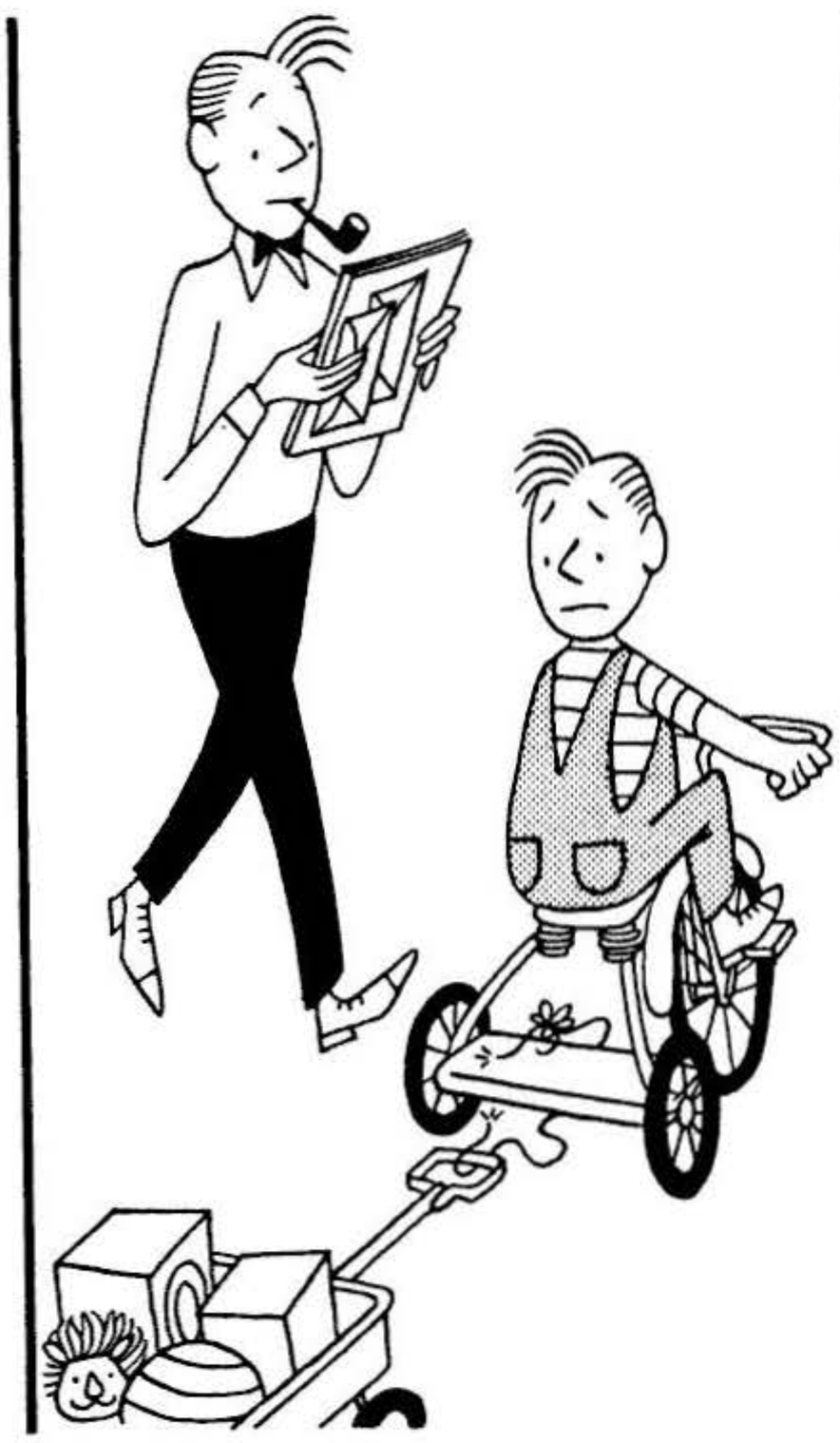
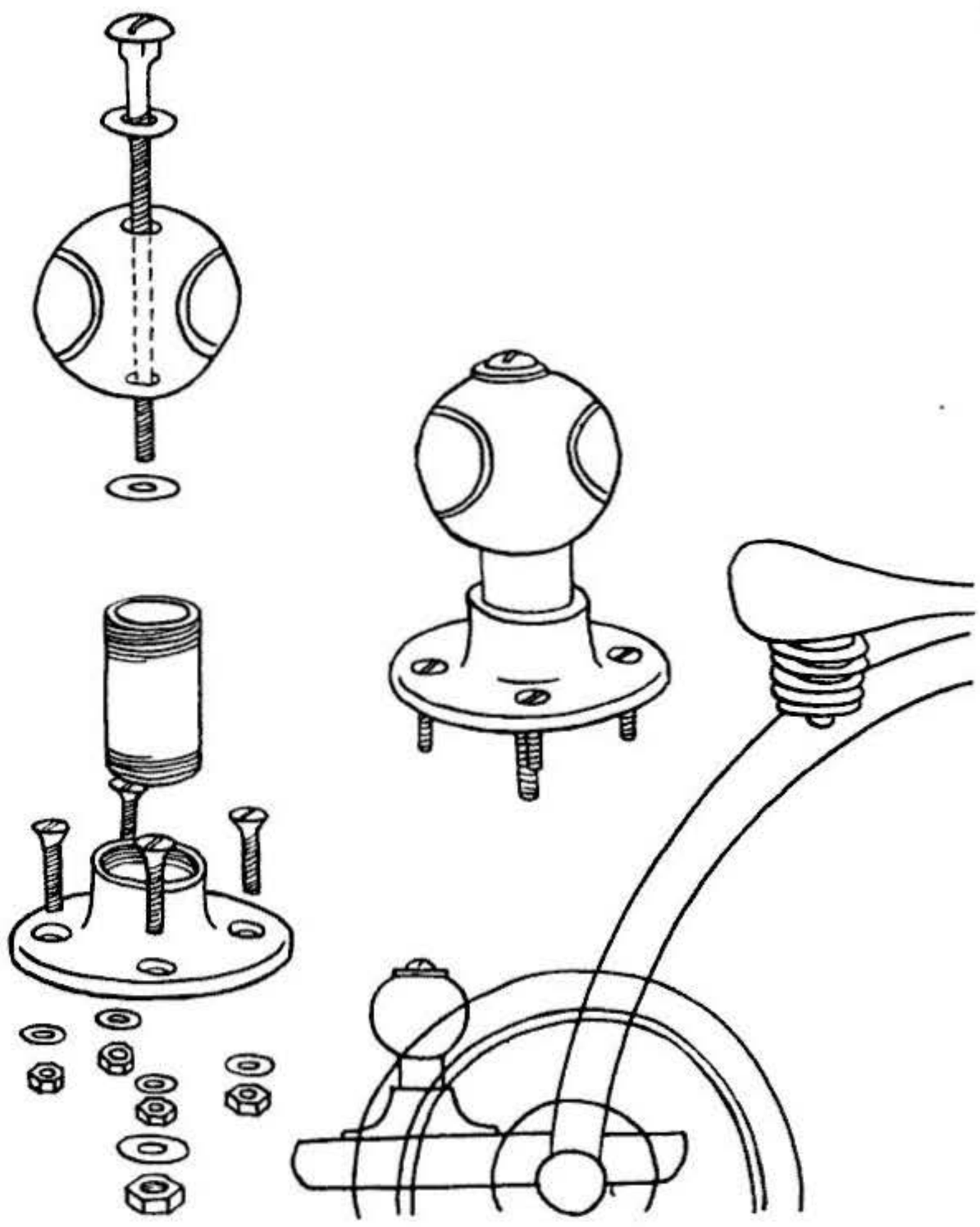
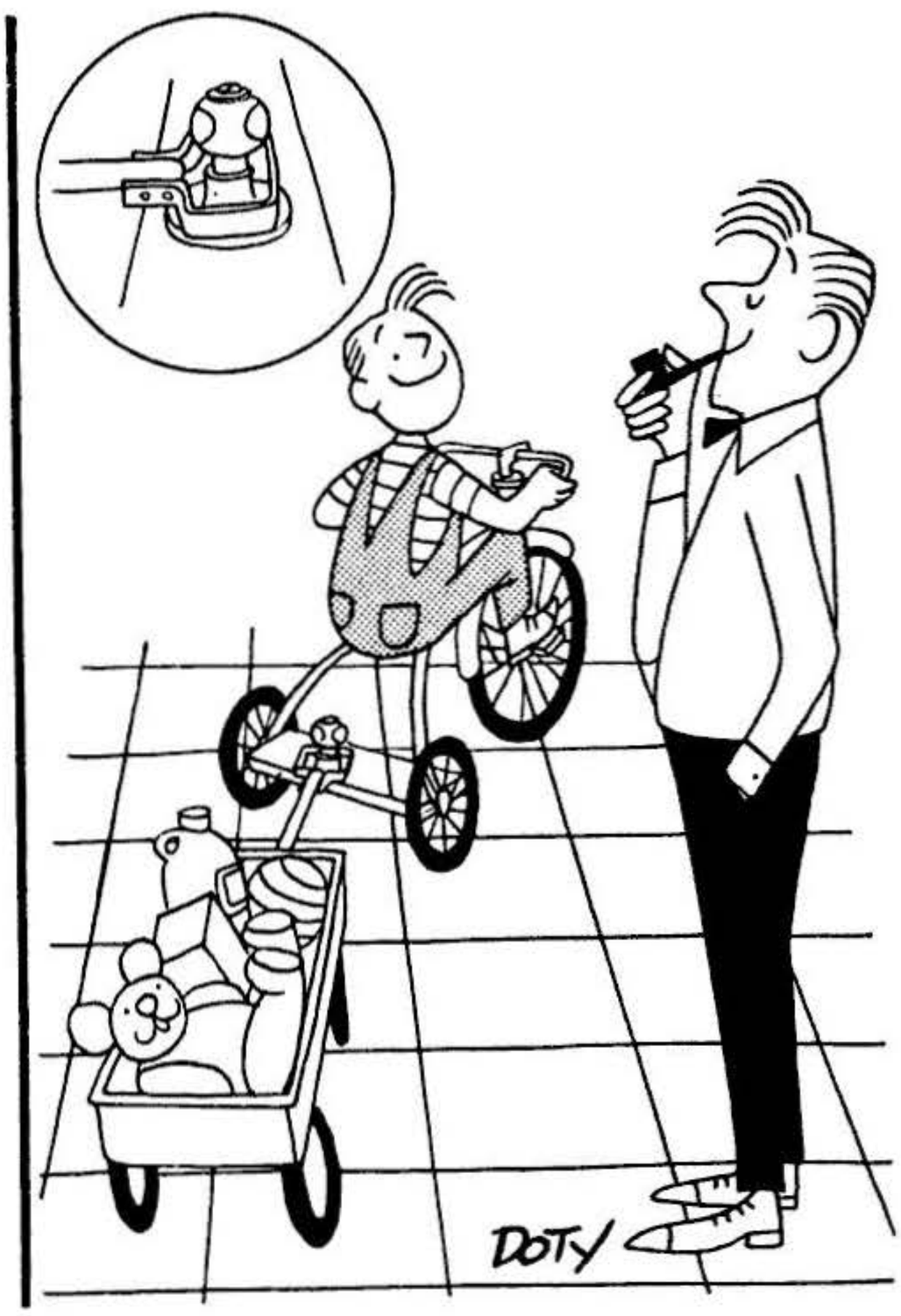
Wordless Workshop

By ROY DOTY









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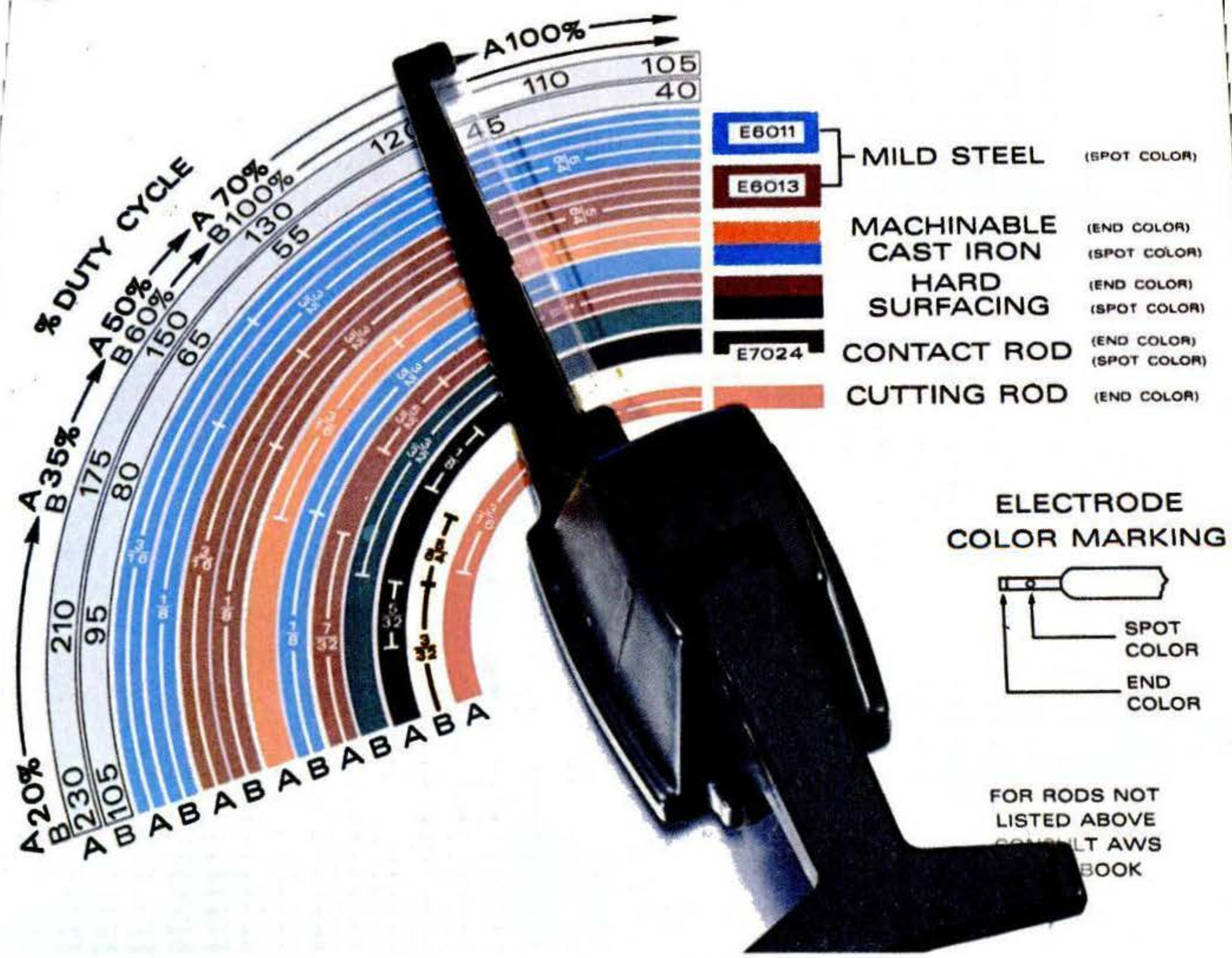
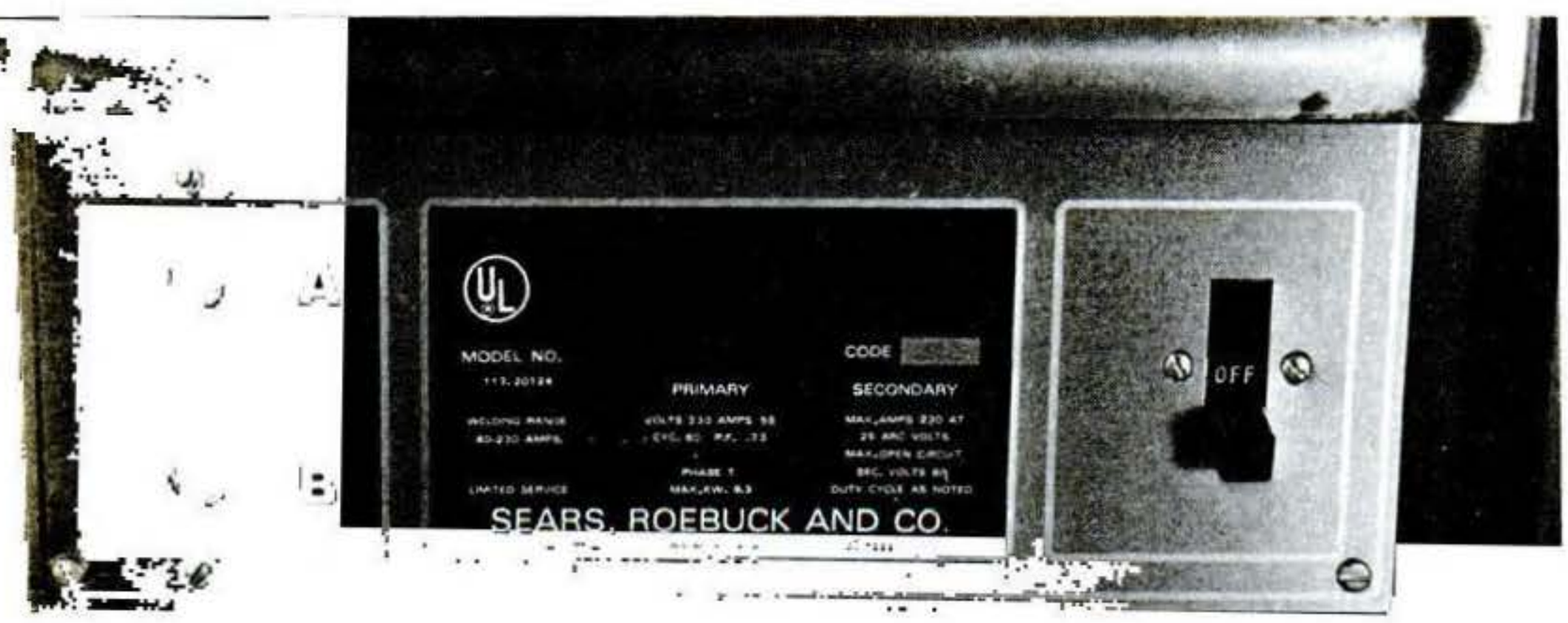


Color-coded top panel on the welder contains enough information to let you start the job immediately. It lists six of the most common welding rods and tells how to identify them, provides a heat range for each rod in various sizes, calls out the circuit to use, and tells what the duty cycle is. Most welders this size have a 20-percent duty cycle. A look at the panel shows less downtime for this welder.



Welding range on the 230-amp model is from 40 to 230 amps. Two circuits are provided: "A" for heat requirements from 230 to 105 and "B" for 105 down to 40. The top panel (photo above) tells you which circuit to use.

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Color-Coded Arc Welder Makes the Job Easier

By R. J. De CRISTOFORO

You can now approach the field of arc welding with confidence even though you never struck an arc before. You do it with the new Sears, Roebuck Color-Matic continuous-control arc welder.

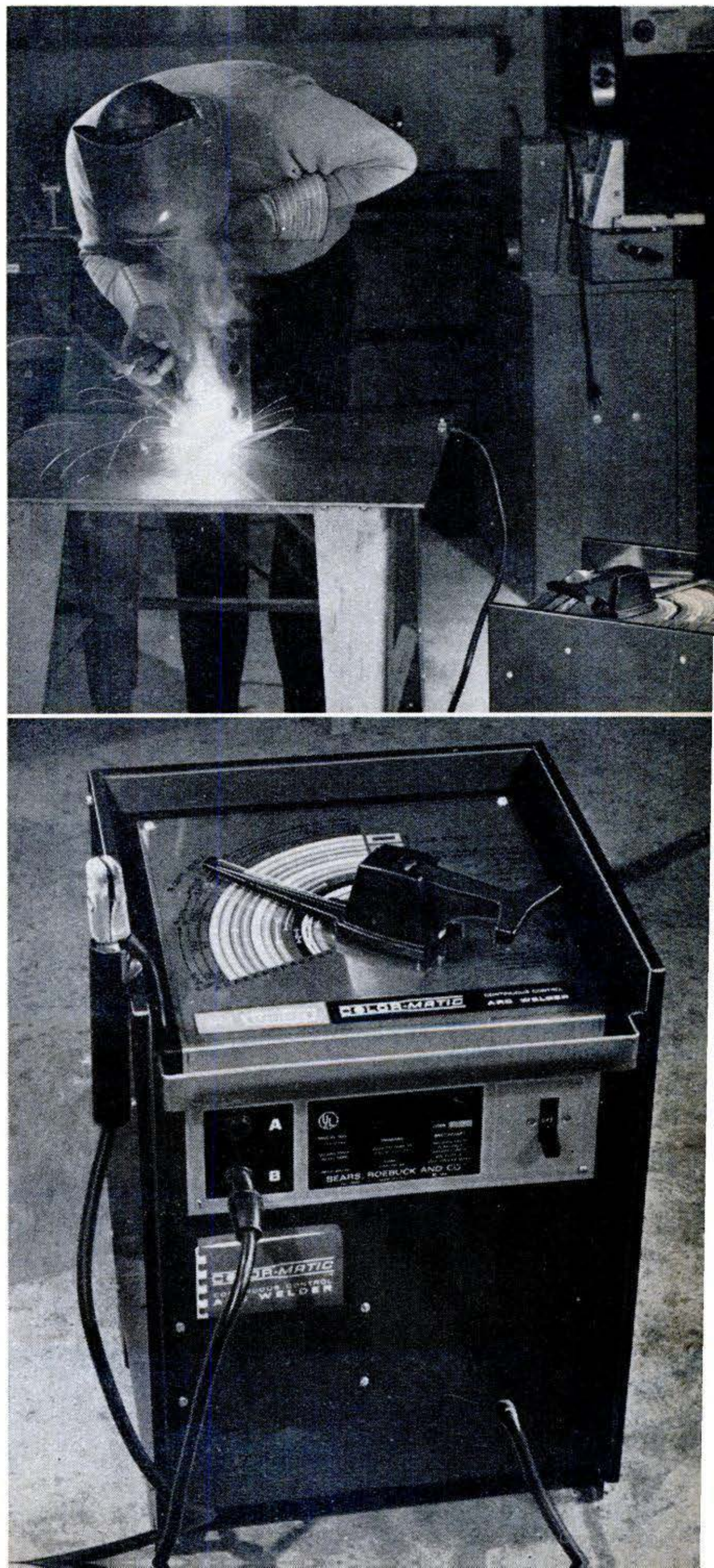
The machine was designed to take advantage of the color-coded welding rods made standard by the American Welding Society. For example, a blue spot on the bare end of the rod identifies it as suitable for mild steel; an orange tip and blue spot tells you that the rod will produce machinable welds on cast iron. Once you have chosen the rod to suit the material, you simply dial the matching color on the welder's top panel.

Heat requirements. The larger the rod, the more heat you need. Therefore, settings that relate to rod size are indicated in each color band. For example, you know exactly where to set the dial to provide the right heat for welding mild steel with a 1/8-inch rod. However, two things might interfere with such settings—a drop in line voltage, and material that is just a bit thicker. You would compensate for this by turning to a slightly higher setting.

This procedure is especially important to the beginner, because it lets him select a condition that is very close to ideal for a good welding job. Unscrambling the variables, which is often a matter of experience, is reduced to reading a chart and turning a handle.

As can be seen in the photo on the facing page, the color-coded top panel contains enough information to let you go to work almost immediately. Besides listing the six most common rods, it tells

Continued



Compactly designed welding machine has a shipping weight of about 130 pounds. Since the unit isn't easy to move about without casters, the author recommends buying a set offered by Sears for $5.

how to identify them, provides the heat range for each rod in various sizes, and tells you which circuit to use, and the duty cycle.

The duty cycle. A knowledge of this factor is important if you want a machine that will last. A duty cycle, on a welder of this size, normally runs about 20 percent. This simply means that you can actually weld two minutes out of every 10; the welder requires the other eight minutes to cool off. Overall, the duty cycles on this welder are high. A quick check of the panel shows that, for a significant number of jobs, the duty cycle runs from 50 to 100 percent.

Why so high? The greater actual use time is made possible by an ingeniously designed transformer; it is wound with fiberglass-insulated strips of aluminum sheet. The fiberglass tolerates heat better than varnish-insulated copper-wound transformers. This, plus an efficient cooling fan, makes for the higher work time with less chance of transformer burnout.

The ABC's. Since all the important factors governing a good setup (and the adjustments for them) are provided on the top panel, there's a tendency to skip using the manual. But, thinking primarily of beginners, I strongly recommend using the information-packed 100-page book that comes with the unit. Besides offering what amounts to a short course in arc welding and special welding techniques, the manual contains a card for each of the electrodes listed on the color-coded panel. Detailed descriptions provide you with all the information you need so you can supplement the mechanical advantages of the machine with your own intelligence.

The arc. Striking and maintaining an efficient arc with conventional rods will require some trial and error on scrap materials. The first time around, the sputter and glow of the arc are disconcerting enough to make an acceptable bead just about impossible. But, as you become accustomed to it, enthusiasm and confidence mount; in short, because you want to, you learn fast.

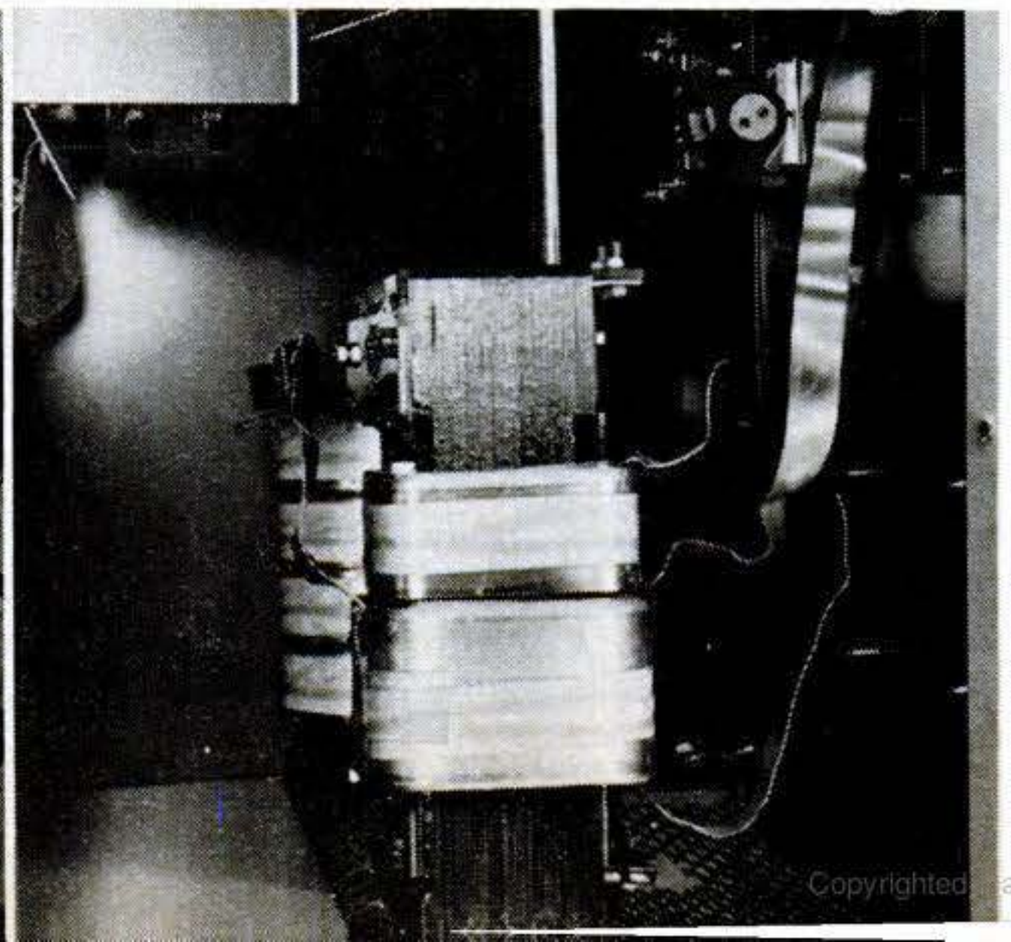
Check out the contact rods. Happily, these new electrodes do the job while maintaining contact with the work. You don't have to maintain an arc; the weld is created simply by dragging the rod along the joint line. The bead is clean, has a fine ripple and no slag inclusions. Also, there is almost a complete lack of smoke and fumes.

Two versions of the new welder are manufactured: One, rated at 180 amps, sells for $126; the second, at 230 amps, is priced at $140. The 230-amp rig gives the most advantages; the other is designed to meet the needs of rural areas where maximum voltage input may be limited.

The package. With the welder you get an 18-inch electrode cable with a heavy-duty holder having copper contact points, a 12-foot ground cable with grounding clamp, fiberglass safety helmet, and a sample bundle of rods that includes several of the contact type. If this is your first welder, plan to add—right at the start—a quality pair of gauntlet-type gloves, a wire brush, and a chipping hammer. PS

Test setup (below) is a good one to duplicate. The top is a piece of ¼-inch steel plate bolted to an old tool stand. The ground cable is bolted to the table so that anything you put on it is automatically grounded.

Insides look deceptively simple. Fiberglass-insulated sheets of aluminum have great heat tolerance, give the welder its high duty cycles. Should you ever wish to peek, unplug first.



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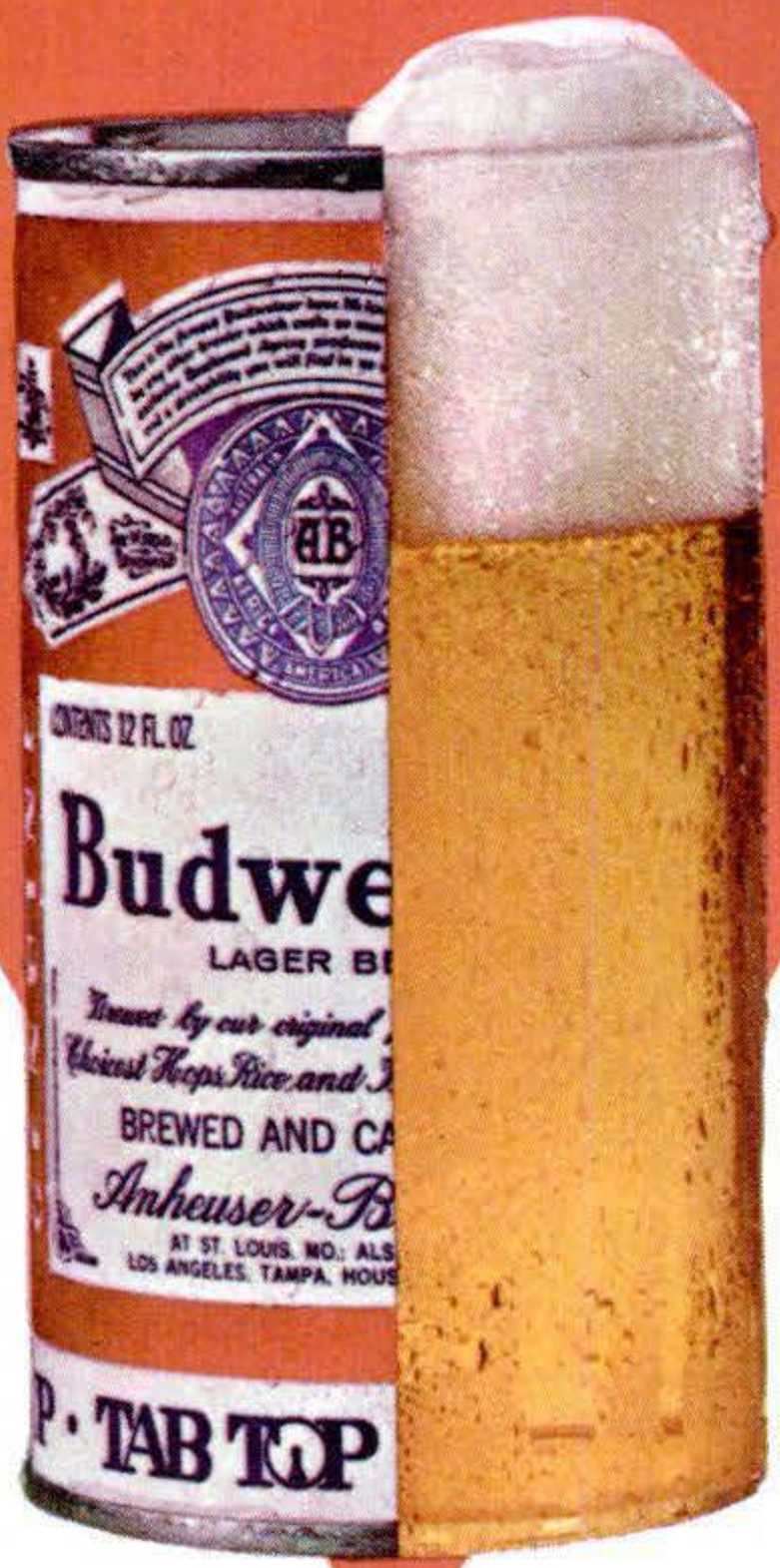

What's on the outside is only part of the story.

"Exclusive Beechwood Ageing...choicest hops, rice, and best barley malt...etc." Significant facts. Ah, but inside...*that's beer!*

Budweiser is the King of Beers.®

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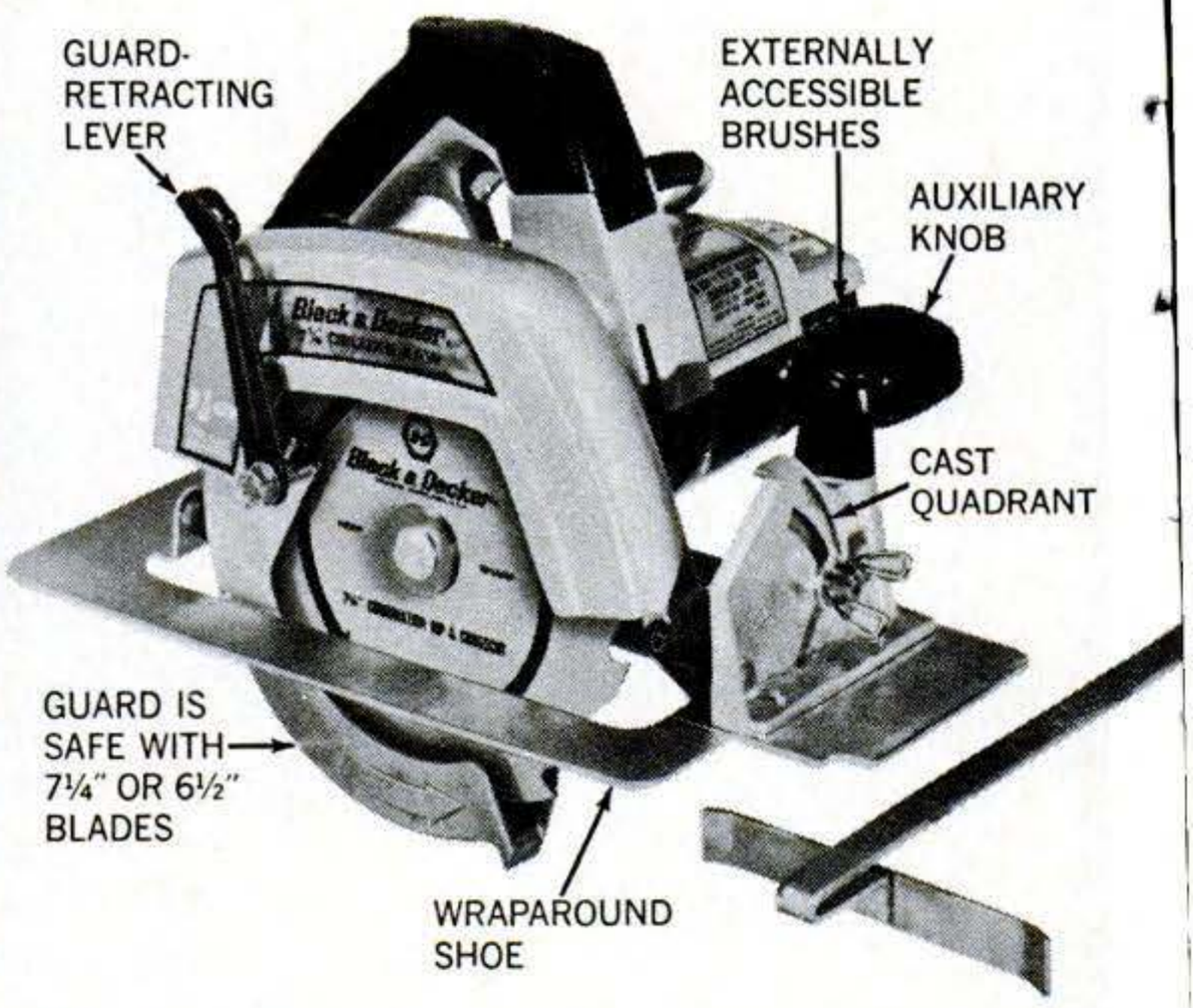
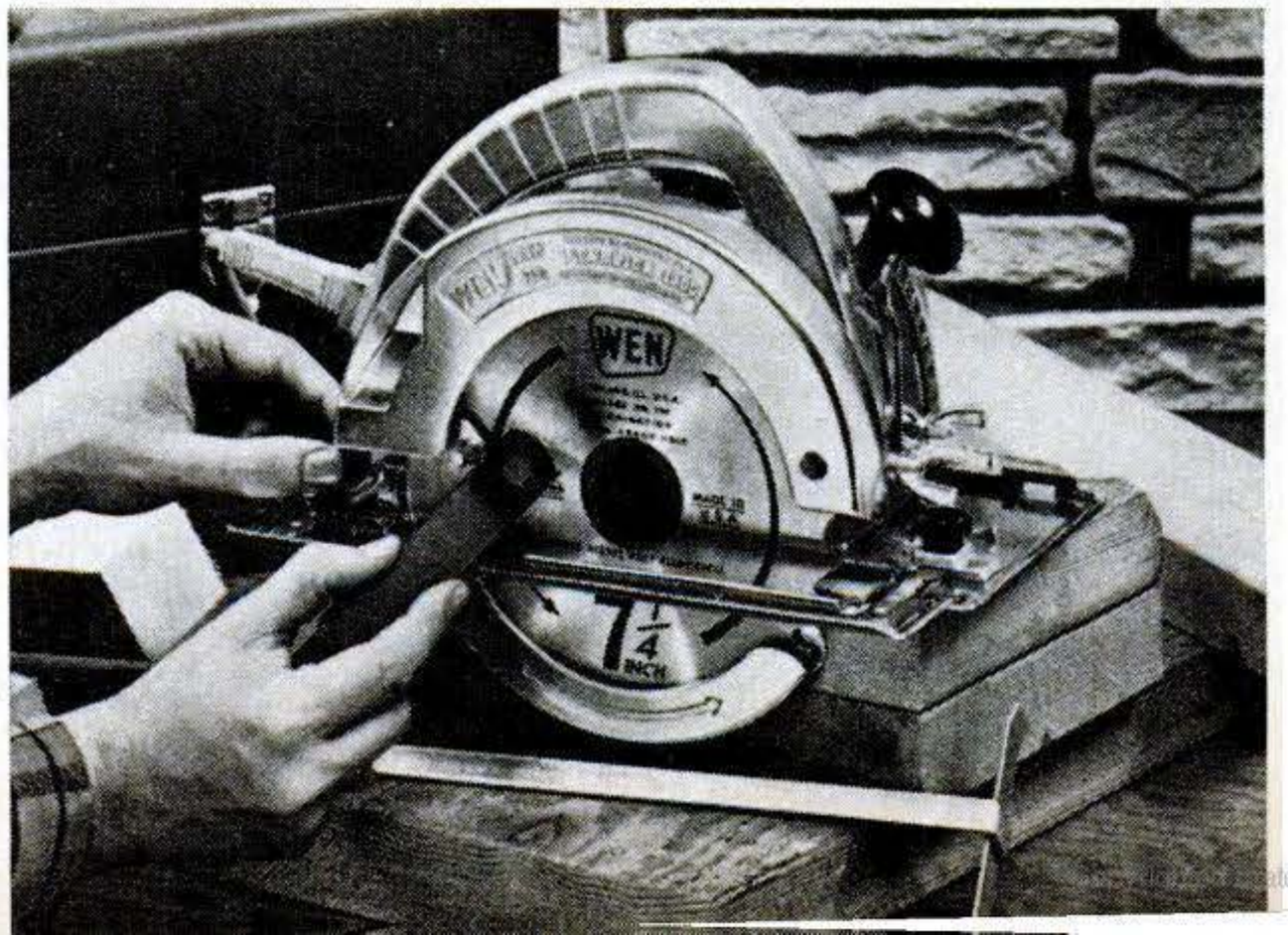
Four New Power Hand Saws



Good balance and comfort-engineered grips make their latest circular saws easier to handle, claim Black & Decker. Model U-131 (above), equipped with a nine-amp 1¼-hp. motor, cuts 2⅜" stock at 90 degrees, 1¾" at 45 degrees. Externally accessible brushes provide ease of service, and an oversize lower blade guard works with 6½" or 7¼" blades. Complete with combination blade and rip guide, the saw sells for $35. Model U-231 (above, right) boasts the same features as its smaller brother, plus a heavy-plate steel shoe with full wraparound for extra support and a cast quadrant for accurate bevel adjustments. Its 9.5-amp motor develops 1½ hp. About $45.

Tiresome finger-pressure control is eliminated on this saber saw (also from Black & Decker) because the variable-speed selector is separated from the U-257's trigger switch. The $45 price includes bevel shoe with quick-change clamp, rip and circle guides. B & D has a new two-speed jigsaw, too (not shown), the U-155, that sells for $20.

The Stallion, a heavy-duty 7¼" circular saw from the Wen stable, now comes in a fitted carrying case, complete with calibrated rip guide, removable outboard shoe extension, even a wrench. The saw is powered by a rugged 12-amp, 2½-hp. air-cooled motor that delivers a no-load running speed of 5,300 r.p.m. Frictionless ball and needle bearings—sealed and permanently lubricated—are used throughout. Built-in safety features: a handle set well behind the blade and an anti-kickback clutch. The 1000K5 kit is $69.50.



This is the extremely accurate, unbelievably inexpensive, and highly embarrassing Remington Model 788.

It wasn't all those things last year, when we introduced it.

Oh, we knew it would be inexpensive, all right. We designed it to sell for less than $90.00, which would make it one of the lowest-priced big-game rifles available.

But it wasn't long after we began selling it that the letters started coming in.

Embarrassing letters.

Some shooters found that their 788's were shooting better than rifles that cost them twice as much. And when your lowest-priced big-game rifle starts shooting like a target rifle, it can be pretty embarrassing, believe us.

Just where did we go wrong? Well, the Remington 788 has the fastest lock time of any center-fire rifle on the market today. (Lock time is the interval between pulling the trigger and when the rifle actually fires.) The 788's lock time is around half that of most other rifles. And that can make a big difference in accuracy.

For instance, we chambered the 788 for the "old, outdated" 30-30 cartridge and found that it would fire three shots into a 1" circle at 100 yards. We chambered it for the "heavy, inaccurate (up until now), short-range" 44 Rem. Magnum and got 3-shot groups of under 1½". The super-accurate varmint calibers, 222 Rem. and 22-250 Rem., we won't talk about; we're embarrassed enough.

This year we're offering the 788 in 243 caliber as well. For $89.95. And if this new caliber shoots as well as the others, we're in for another embarrassing year.

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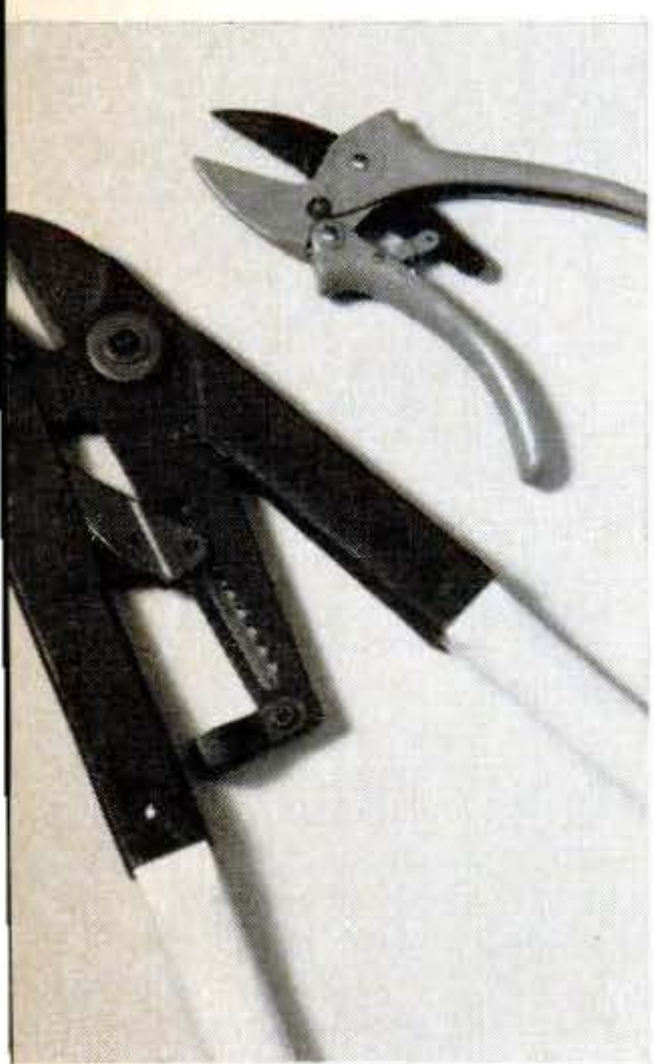
It's not an inexpensive rifle that's also accurate; it's an accurate rifle that's also inexpensive.

*Fair Trade prices in states having Fair Trade laws.

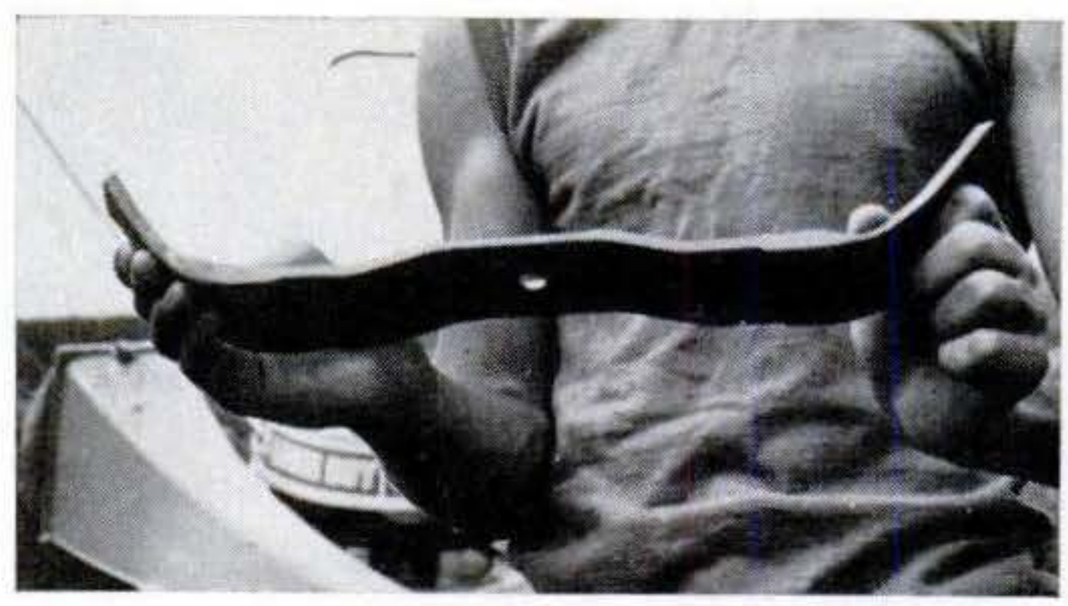
Write for free 1969 Remington catalog: Remington Arms Company, Inc., Bridgeport, Conn. 06602. In Canada: Remington Arms of Canada Limited.

What's New for Yard Work

Skil's first rotary mower, an 18-inch electric, is said to be the most powerful in its size class. It weighs only 48 pounds and features a burnout-protected motor and seven cutting heights. A bracket on the handle keeps the cord out of the way. The handle folds for storage, or converts to a wall hanger for your garage or tool shed. $104.95.



Ratchet principle enables the Florian Perfect Pruner to give increasing leverage as you cut through a heavy branch. You begin cutting in the normal manner until action becomes hard, then open the handles slightly until a toggle pin clicks into the next notch on the blade, to give you more leverage. Construction is of hardened carbon and alloy steels. The price is $29.95 for the larger pruners, $5.95 for the hand clippers. The tools are manufactured by American Standard Co., Plantsville, Conn. 06479.



A semirigid, nonmetal blade for a rotary mower reduces the chance of accidents, yet, says the maker, will cut as well as a metal blade. Striking a solid object, the blade flexes—it will scuff a shoe, not cut it. It's made of an elastomer—a substance with properties of rubber and plastic. Made by Dayco Corp., Dayton, Ohio 45401.

Scalloped contour blades on Black & Decker's new double-edge shrub and hedge trimmers give cleaner cuts with less strain on the motor. Blades slice, rather than chop. Both models, with either 13-inch or 22-inch cutter, have lightweight die-cast aluminum housing and wraparound handle for easy maneuvering in any position. The 13-inch model (far left) sells for $23.88; the 22-incher (photo, near left) is $39.99.

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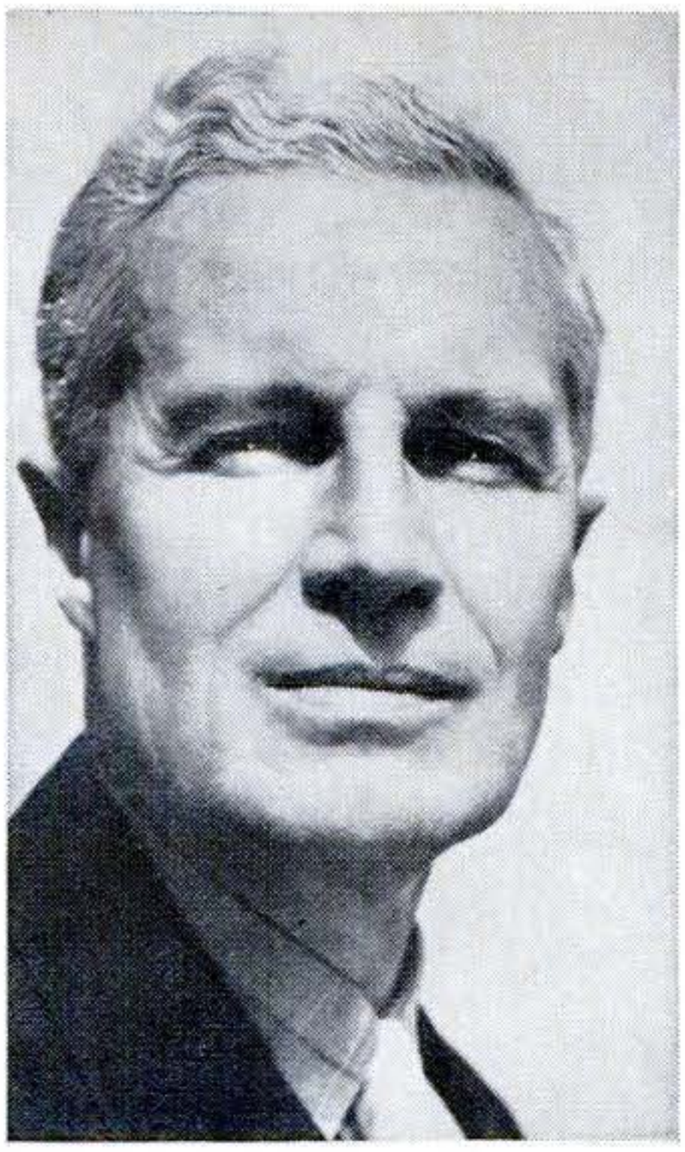

I'd like to give this to my fellow men...

while I am still able to help!

I was young once, as you may be—today I am older. Not too old to enjoy the fruits of my work, but older in the sense of being wiser. And once I was poor, desperately poor. Today almost any man can stretch his income to make ends meet. Today, there are few who hunger for bread and shelter. But in my youth I knew the pinch of poverty; the emptiness of hunger; the cold stare of the creditor who would not take excuses for money. Today, all that is past. And behind my city house, my summer home, my Cadillacs, my winter-long vacations and my sense of independence—behind all the wealth of cash and deep inner satisfaction that I enjoy—there is one simple secret. It is this secret that I would like to impart to you. If you are satisfied with a humdrum life of service to another master, turn this page now—read no more. If you are interested in a fuller life, free from bosses, free from worries, free from fears, read further. This message may be meant for you.

By Victor B. Mason

I am printing my message in a magazine. It may come to the attention of thousands of eyes. But of all those thousands, only a few will have the vision to understand. Many may read; but of a thousand only you may have the intuition, the sensitivity, to understand that what I am writing may be intended for you—may be the tide that shapes your destiny, which, taken at the crest, carries you to levels of independence beyond the dreams of avarice.

Don't misunderstand me. There is no mysticism in this. I am not speaking of occult things, of innumerable laws of nature that will sweep you to success without effort on your part. That sort of talk is *rubbish!* And anyone who tries to tell you that you can *think* your way to riches without effort is a false friend. I am too much of a realist for that. And I hope you are.

I hope you are the kind of man—if you have read this far—who knows that anything worthwhile has to be *earned!* I hope you have learned that there is no reward without effort. If you have learned this, then you may be ready to take the next step in the development of your karma—you may be ready to learn and use the secret I have to impart.

I Have All The Money I Need

In my own life I have gone beyond the need of money. I have it. I have gone beyond the need of gain. I have two businesses that pay me an income well above any amount I have need for. And, in addition, I have the satisfaction—the deep satisfaction—of knowing that I have put more than three hundred other men in businesses of their own. Since I have no need for money, the greatest satisfaction I get from life is sharing my secret of personal independence with others—seeing them achieve the same heights of happiness that have come into my own life.

Please don't misunderstand this statement. I am not a philanthropist. I believe that charity is something that no proud man will accept. I have never seen a man who was worth his salt who would accept something for nothing. I have never met a highly successful man whom the world respected who did not sacrifice something to gain his position. And, unless you are willing to make at least half the effort, I'm not interested in giving you a "leg up" to the achievement of your goal. Frankly, I'm going to charge you something for the secret I give you. Not a lot—but enough to make me believe that you are a little above the fellows who merely "wish" for success and are not willing to sacrifice something to get it.

A Fascinating and Peculiar Business

I have a business that is peculiar—one of my businesses. The unusual thing about it is that it is needed in every little community throughout this country. But it is a business that will never be invaded by the "big fellows." It has to be handled on a local basis. No giant octopus can ever gobble up the whole thing. No big combine is ever going to destroy it. It is essentially a "one man" business that can be operated without outside help. It is a business that is good summer and winter. It is a business that is growing each year. And, it is a business that can be started on an investment so small that it is within the reach of anyone who has a television set. But it has nothing to do with television.

This business has another peculiarity. It can be started at home in spare time. No risk to present job. No risk to present income. And no need to let anyone else know you are "on your own." It can be run as a spare time business for extra money. Or, as it grows to the point where it is paying more than your present salary, it can be expanded into a full time business—overnight. It can give you a sense of personal independence that will free you forever from the fear of lay-off, loss of job, depressions, or economic reverses.

Are You Mechanically Inclined?

While the operation of this business is partly automatic, it won't run itself. If you are to use it as a stepping stone to independence, you must be able to work with your hands, use such tools as hammer and screw driver, and enjoy getting into a pair of blue jeans and rolling up your sleeves. But two hours a day of manual work will keep your "factory" running 24 hours turning out a product that has a steady and ready sale in every community. A half dollar spent for raw materials can bring you six dollars in cash—six times a day.

In this message I'm not going to try to tell you the entire story. There is not enough space on this page. And, I am not going to ask you to spend a penny now to learn the secret. I'll send you all the information, free. If you are interested in becoming independent, in becoming your own boss, in knowing the sweet fruits of success as I know them, send me your name. That's all. Just your name. I won't ask you for a penny. I'll send you all the information about one of the most fascinating businesses you can imagine. With these facts, you will make your own investigation. You will check up on conditions in your neighborhood. You will weigh and analyze the whole proposition. Then, and then only, if you decide to take the next step, I'll allow you to invest $15.00. And even then, if you decide that your fifteen dollars has been badly invested I'll return it to you. Don't hesitate to send your name. I have no salesmen. I will merely write you a long letter and send you complete facts about the business I have found to be so successful. After that, you make the decisions.

Does Happiness Hang on Your Decision?

Don't put this off. It may be a coincidence that you are reading these words right now. Or, it may be a matter that is more deeply connected with your destiny than either of us can say. There is only one thing certain: If you have read this far you are interested in the kind of independence I enjoy. And if that is true, then you must take the next step. No coupon on this advertisement. If you don't think enough of your future happiness and prosperity to write your name on a postcard and mail it to me, forget the whole thing. But if you think there is a destiny that shapes men's lives, send your name now. What I send you may convince you of the truth of this proverb. And what I send you will not cost a penny, now or at any other time.

VICTOR B. MASON
1512 Jarvis Ave., Suite M-3-BS
CHICAGO, ILLINOIS 60626

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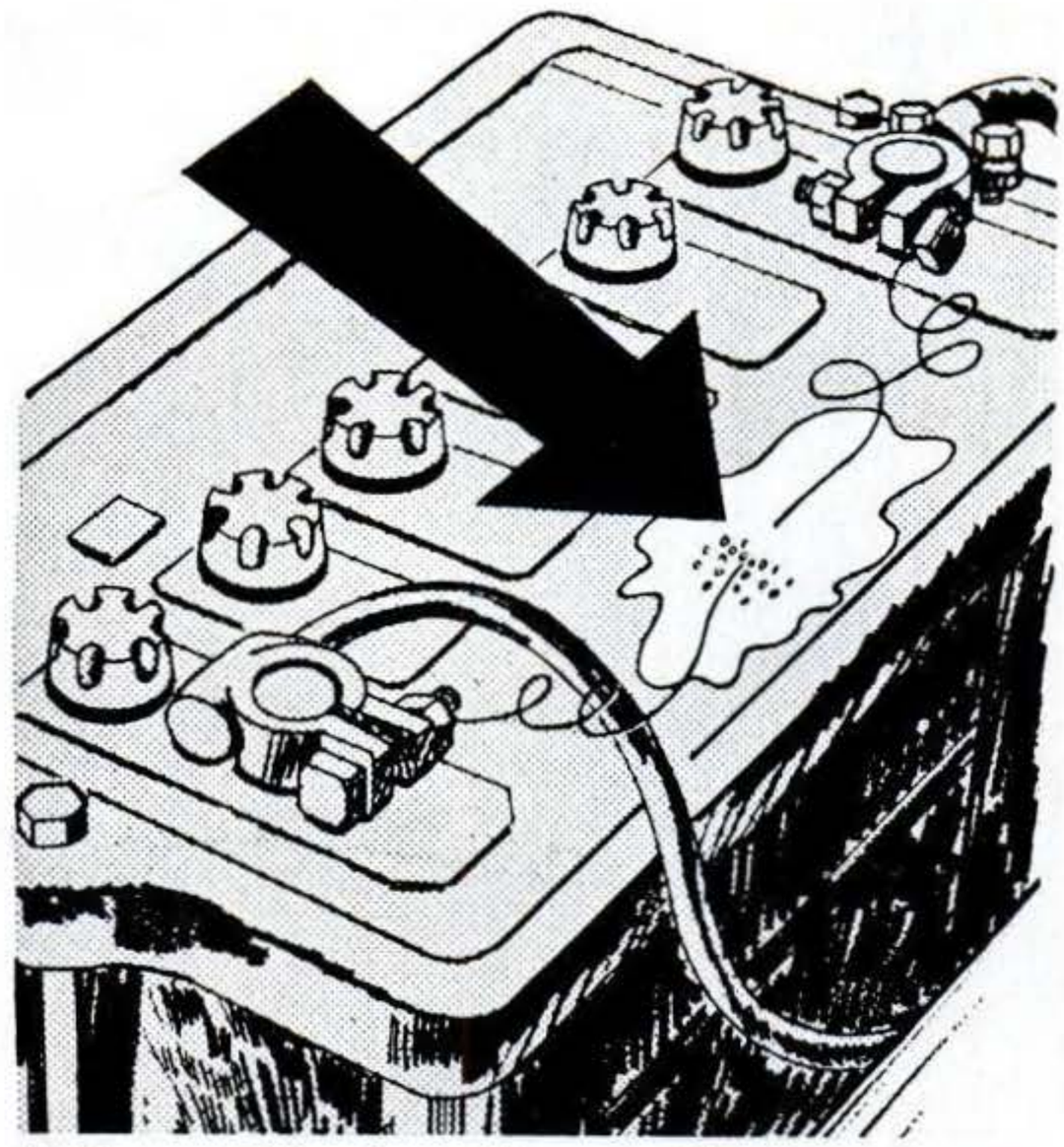
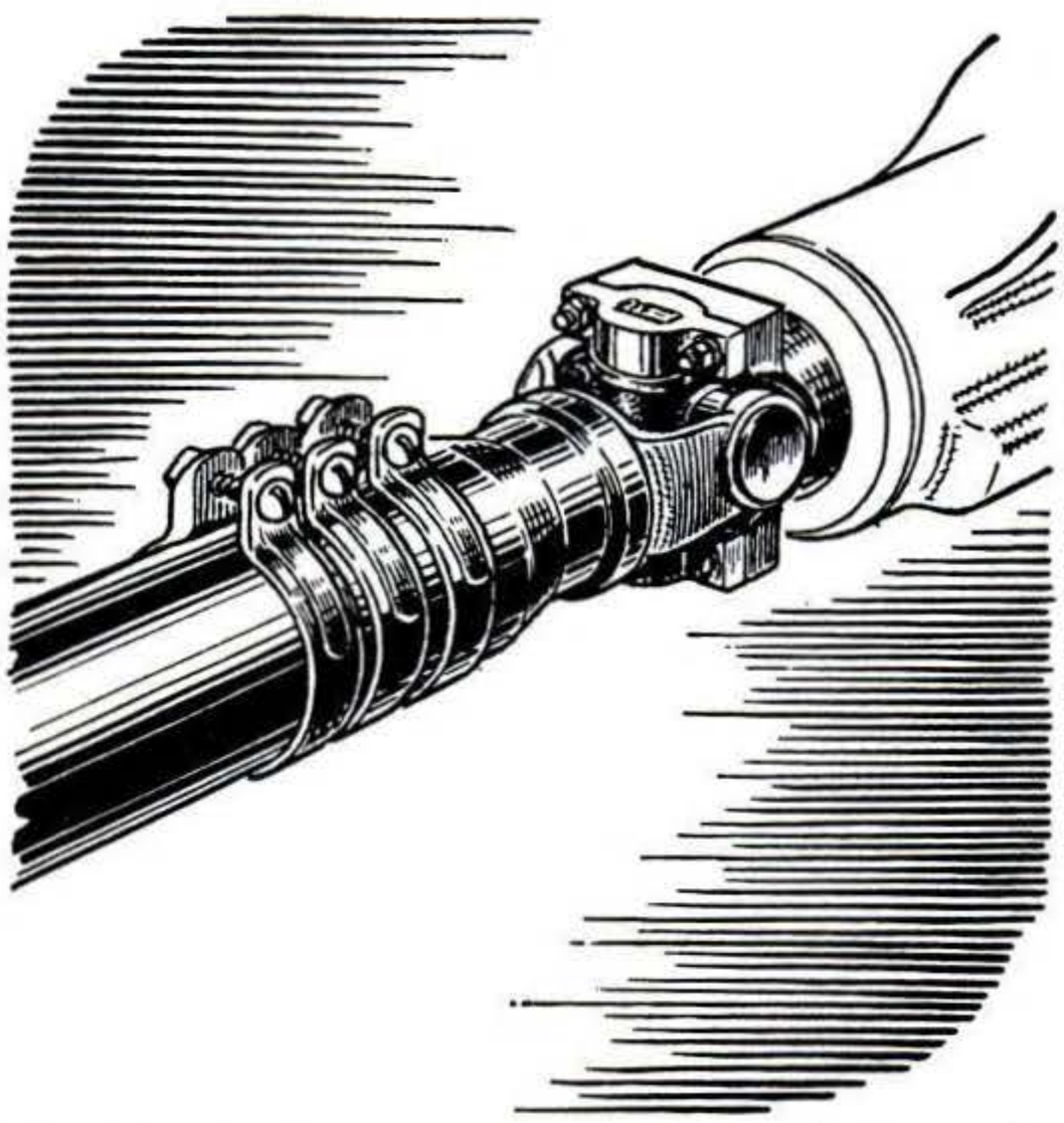
Hints from the Model Garage

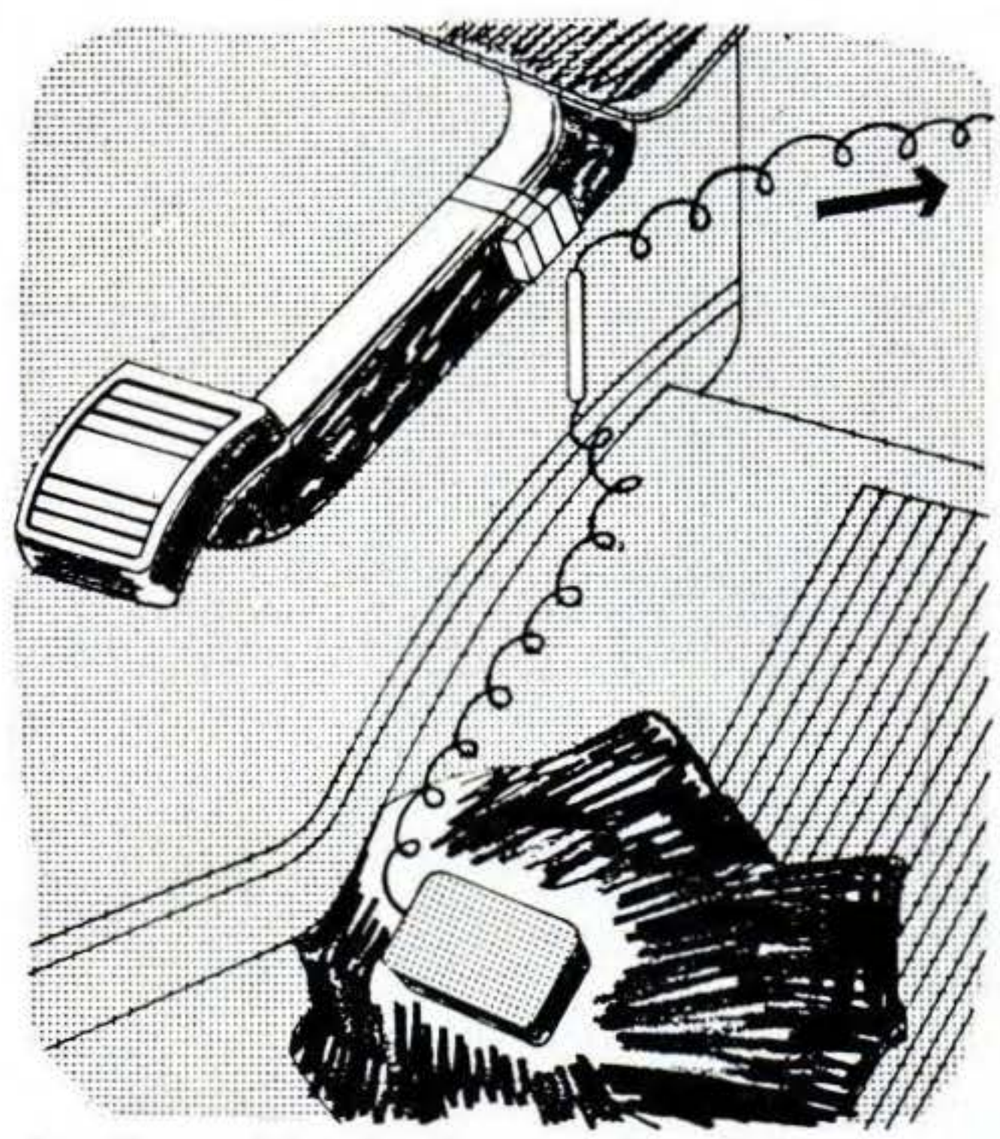
To remove the exhaust pipe when you're cutting loose a muffler, do it this easy way. Turn a hacksaw upside down and hold it around the pipe; then insert the blade with the edge toward the frame. This gives you more leverage, and the saw will bind less.



If the positive/negative markings are worn off your battery posts, you can identify the terminals by dipping the ends of two wires connected to the terminals into a small pool of electrolyte. Watch for bubbles from one wire—that's the negative one.



Vibrations in a car can sometimes be traced to an out-of-balance propeller shaft. If it's a slight eccentricity or out-of-roundness, you can fix it with a couple of hose clamps tightened around the shaft, with the screws positioned opposite the eccentricity.



A simple parking-brake warning light can be made with a magnetic reed switch and a magnet. Tape the magnet to the brake-pedal arm and install the switch so it's actuated when the brake is applied. Fit a warning light on the dash and wire it in series.

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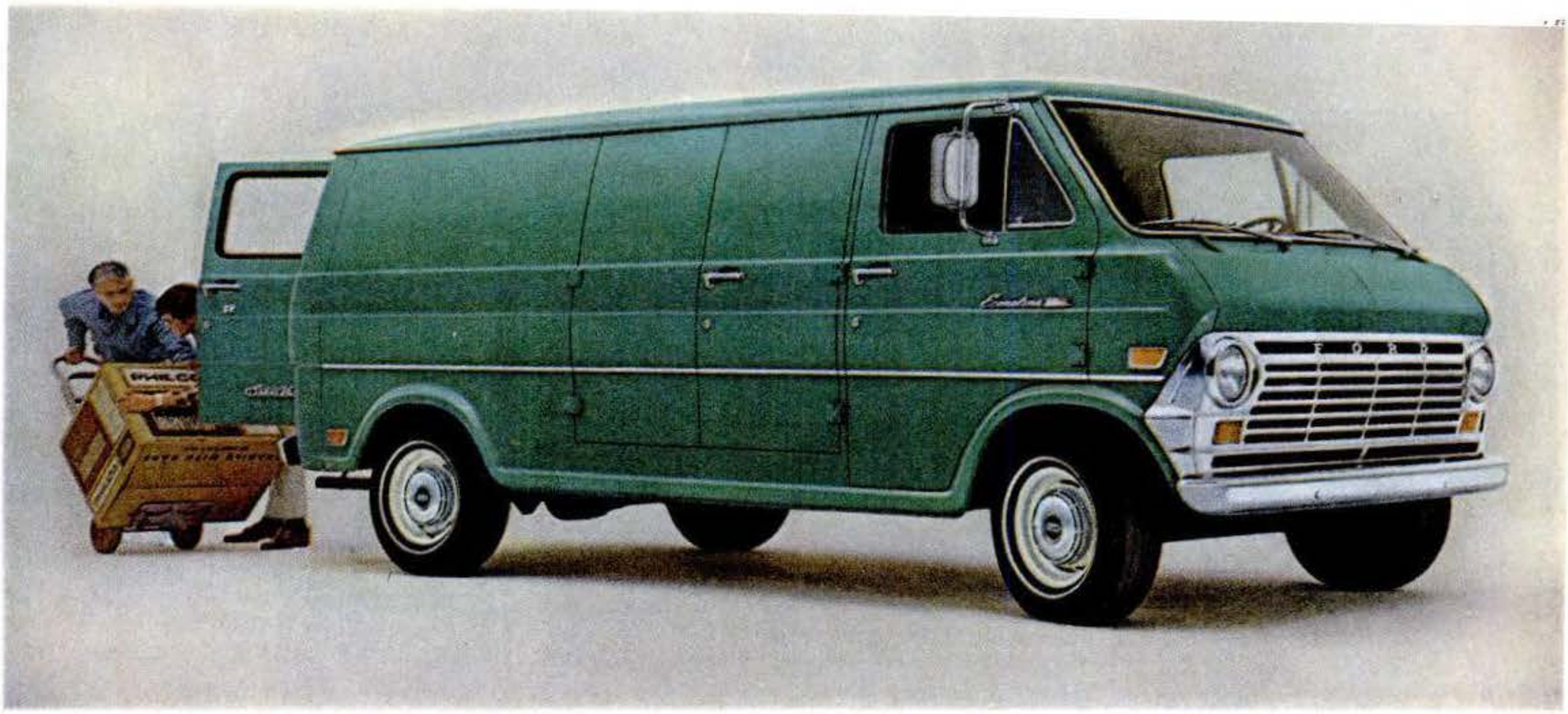

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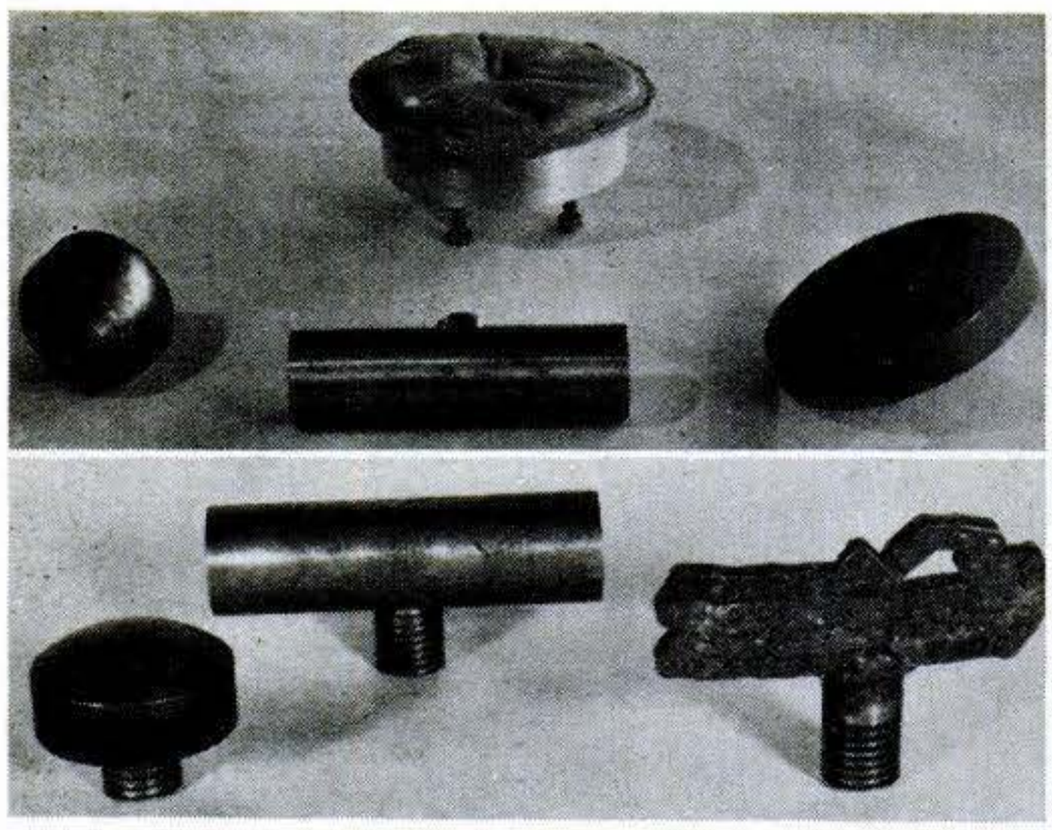
[Continued from page 124]

ly, "is a minimum standard, and many people are treating it as a maximum one." The "high-hazard" qualification was inserted, he says, to exempt the average motorist but not the street-riding motorcyclist, who is much more vulnerable.

Unconvinced, Professor Patrick helped devise a lower set of standards at the request of the Motorcycle, Scooter and Allied Trades Assn., a trade organization of manufacturers and importers of two-wheelers and parts for them. The M.S. & A.T.A. specifications were different in one crucial way from the Z90.1 standards: They required only one impact in each designated area of the helmet, instead of two consecutive blows.

One blow vs. two. Scientifically the facts are hard to determine. Arguing for the one-blow standard, John R. Thompson of Buco contrasts the auto-racing driver and the average motorcyclist: "The driver is generally belted into his vehicle. Under accident conditions, it is likely that he would strike such objects as a roll bar, or other components of the vehicle, more than once with the same approximate force."

But a cyclist, Thompson says, "is usually thrown from his vehicle and subject to striking a variety of objects although he is constantly slowing down. His chances of hitting the same type of object or surface with an equal force on the exact same place on the helmet a second time would be considered minimal and not representative of the conditions most frequently encountered in actual helmet use."



Assortment of striking faces for helmet test includes roll-bar stock, flat surface, 1.9-inch radius bob, and section of bicycle chain. The chain is mainly used for testing helmets purchased for police.

Asked to comment on Thompson's statement, a spokesman for another leading helmet maker pointed out that it's not just a matter of how many blows land on the same spot. "Roughly speaking," he said, "it doesn't matter whether you strike a helmet with one 100-foot-pound impact or with two 50-foot-pound impacts. They add up to the same thing because the nonresilient liner is destroyed in proportion to the energy it absorbs. What counts is the total energy-absorbing capability of the helmet, and one that can take only a single impact of a certain amount offers much less protection than a helmet that can take two."

Dr. Snively's experiments confirm a significant difference in the impact-resisting capabilities of helmets that meet the two standards. Those meeting Z90.1 standards, he says, protect at speeds of 15 to 20 m.p.h.; those meeting M.S. & A.T.A. standards protect against 13- to 15-m.p.h. impacts.

In the states—confusion. State helmet laws are a hodgepodge. Seven states require helmets meeting the Z90.1 standard, 20 specify the M.S. & A.T.A., four accept any of several standards, four have standards pending, three have helmet laws with no standards, and 12 have no helmet law at all.

There is one hopeful sign in all this confusion. The Safety Helmet Council of America, an association of helmet manufacturers organized a few years ago to standardize the standards, has endorsed the Z90.1 specifications. It began applying its yellow SHCA label to helmets manufactured after June 1, 1968—if they meet Z90.1 standards.

If you live in Alabama, Connecticut, Missouri, New Hampshire, New Jersey, North Carolina, or Wisconsin, your helmet must meet Z90.1 specs by law. If not, you can get a safer helmet by insisting on one that has an SHCA or a September, 1967, Snell Foundation label. But there's a catch: A helmet labeled "Z90 Approved" may or may not meet Z90.1 standards, depending on the manufacturer's integrity in certifying it. PS

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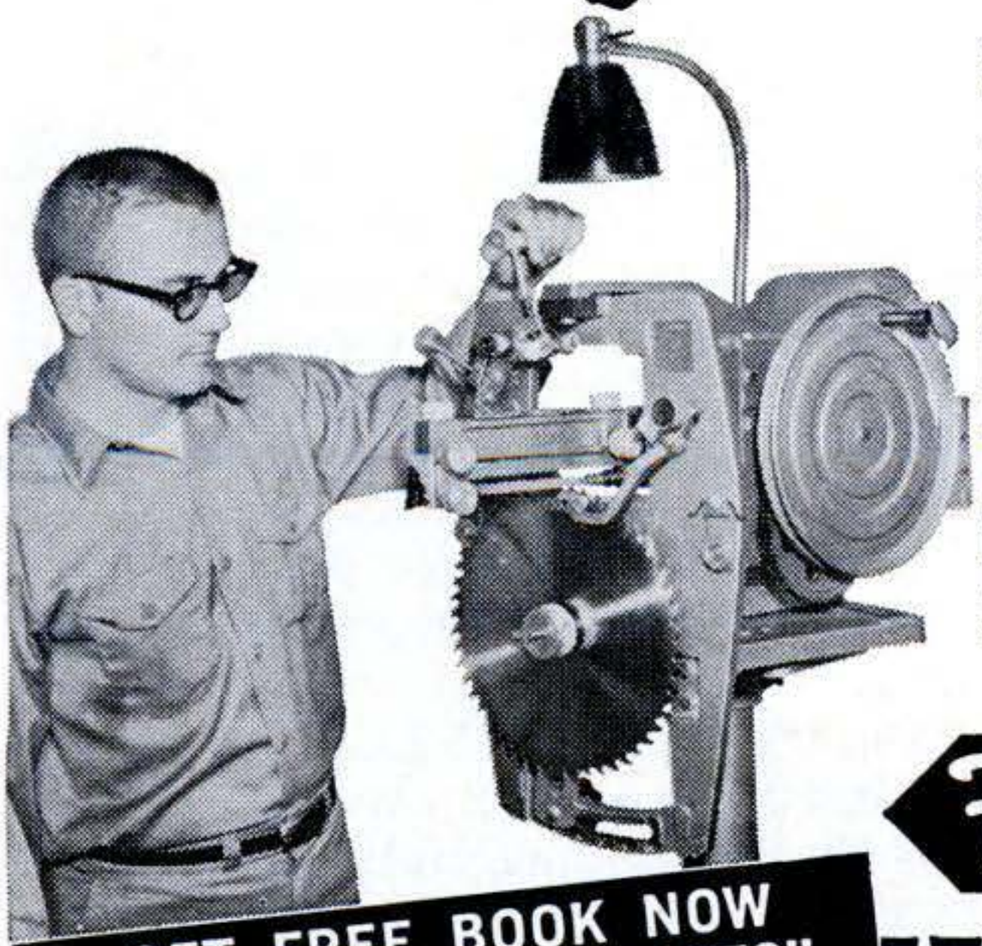

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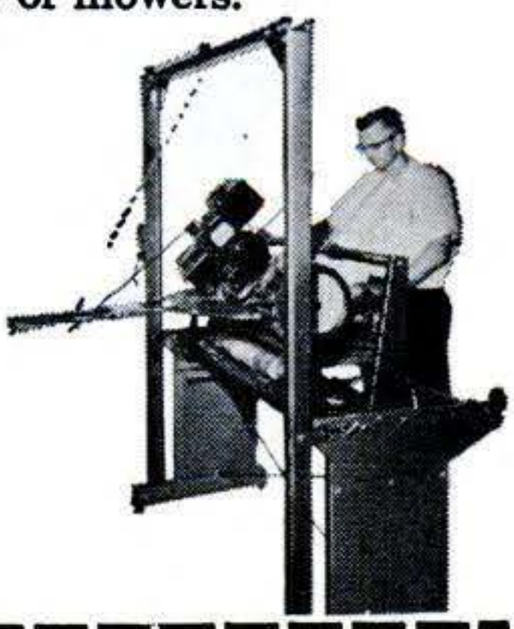
Hundreds of people like yourself are making cash like this — $20 to $30 a week — right now in spare time. *"My spare time saw filing business has made me $952 these first ten months" — says R. T. Chapman.* Many have built a complete sharpening service with such year-around profits. You can too, simply by following the sure, easy Foley Plan.



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How We Film Under the Sea

[*Continued from page 69*]

two movie cameras mounted below them. They make good pictures possible at ranges up to 20 feet in clear water. Two other lights are also used: a 150-watt searchlight for sailing and a 60-watt lamp to light the ocean bottom.

Diving the subs. With the pilot in the sub and the hatch tightly closed, the small two-ton vessel is swung over the stern of the Calypso by a winch. A scuba diver rides down with the sub to free the line when it is in the water. A 55-pound weight carries the Sea Flea to the bottom and is then dropped. To pinpoint buoyancy, the pilot can then admit up to 44 pounds of water into a ballast tank or drop, individually, a number of the small two-pound weights carried for this purpose.

The mercury trim system instantly adjusts the sub's longitudinal angle. This works by shifting 143 pounds of mercury between the front of the sub and the back. To surface, a "standard" 44-pound weight is dropped. In an emergency, this can be supplemented by dropping the mercury and another 110-pound safety weight.

The Sea Fleas carry a tank of oxygen adequate for 20 hours underwater. A special compound absorbs the pilot's exhaled carbon dioxide. The barometer provides a convenient means of monitoring pressure. As oxygen content drops, it is replenished from the supply tank.

The Sea Fleas are not limited to photography. They can mount a mechanical arm and claw for bringing back biological and geological samples from the bottom.

Small as they are, my tiny subs are helping to test principles we will use in future submersibles. Built at a cost of $750,000 by Sud Aviation and in operation for over a year, they are the forerunners of go-anywhere underwater vehicles that will use fuel cells for unlimited range and mobility.

During my active life I have lived with the sea and in the sea. I have accumulated a great many feelings and impressions, things that I would like to communicate to make you understand why our work has been worthwhile, and why we must continue our research and exploration. It is my hope that, before I am relegated to a desk as the elderly director of an institute, I may continue to do so. PS

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How to Survive in Rough Water

[Continued from page 113]

grip, ultimately tearing out a lower engine unit or transom. Motor cavitation is deadly.

Cut speed! If the course demands running in the trough, resort to a series of tacks. Let the gale blow first directly on the bow, then on the quarter. Run a zigzag compass heading that forces you to steer abeam of the sea only long enough to make a turn.

With a fast outboard, maneuver so the boat turns swiftly just after the crest of one breaker and before the next. Operating an inboard cruiser, allow it to lose headway in either direction, throw the wheel hard over, then suddenly apply a good amount of throttle.

A good helmsman makes miniature tacks between waves. As the hull lifts, swing off on the quarter till the wave passes. Head up on course again till it's time for the next jog. Advance throttle slightly while making progress; retard it for safety and comfort near wave crests.

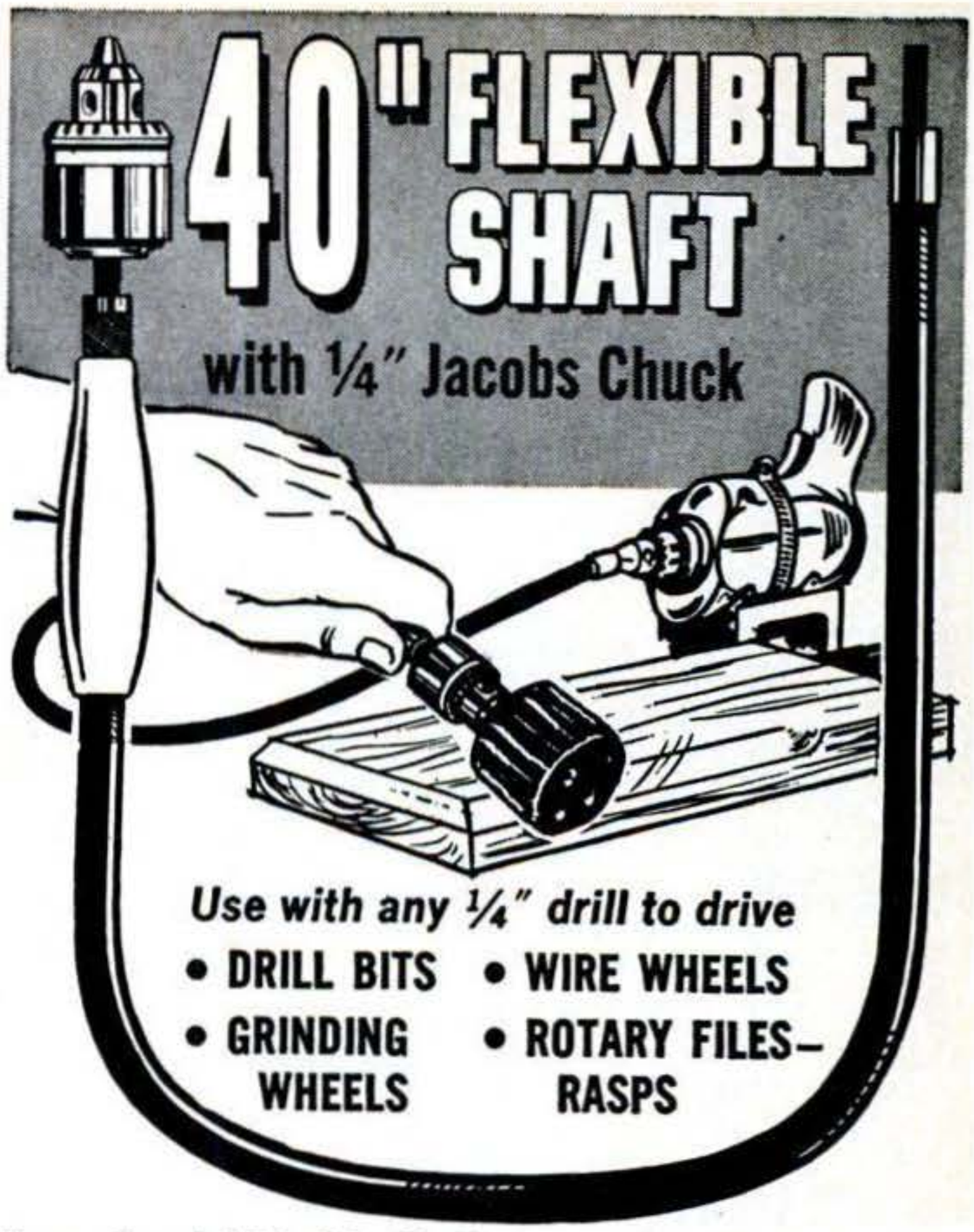
The following sea. What actually happens here is that a wavecrest hurls the hull, getting up underneath somewhere amidships so your prop clears the water. Without power, you lose control.

As a comber strikes under the boat, it shoves the stern sideways and the bow down. In an extreme case, the bow will be buried in green water forward so the hull trips, pitchpoling end over end. In a less spectacular maneuver, the hull simply swings broadside and swamps.

If you're running a heavy boat with limited speed, lose enough way to permit the combers to pass underneath and past you—all the while keeping the bow on course. As a swell picks up, cut the throttle so the boat settles back instead of racing on. If a broach still threatens, get a crewman to pay off a line aft. Drag a pail or other object. Make sure the line is expertly handled so it won't foul the prop.

In a lightweight outboard, climb halfway up the crest of a sea and stay there. Use less rather than more speed. You can always give the engine more gas. You can't cut back once you're hurtling down the face of a breaker.

Most important rule: Don't panic! If caught afloat in rough water, slow down and steer homeward at a snail's pace. PS



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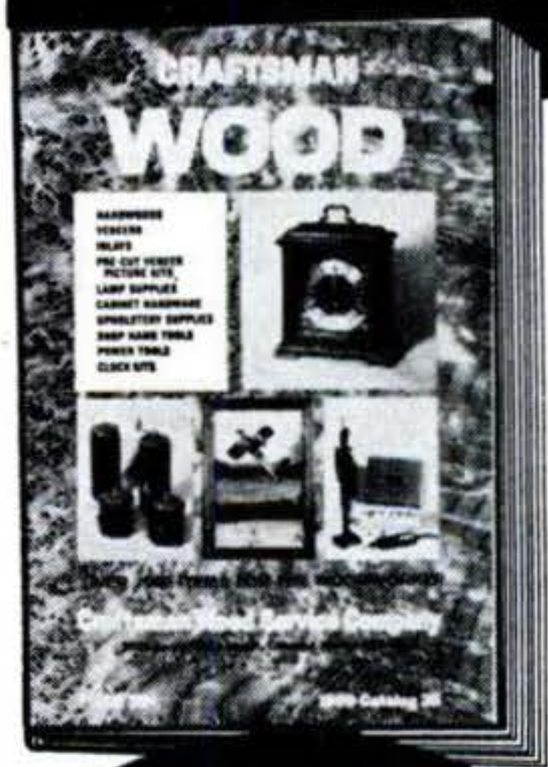

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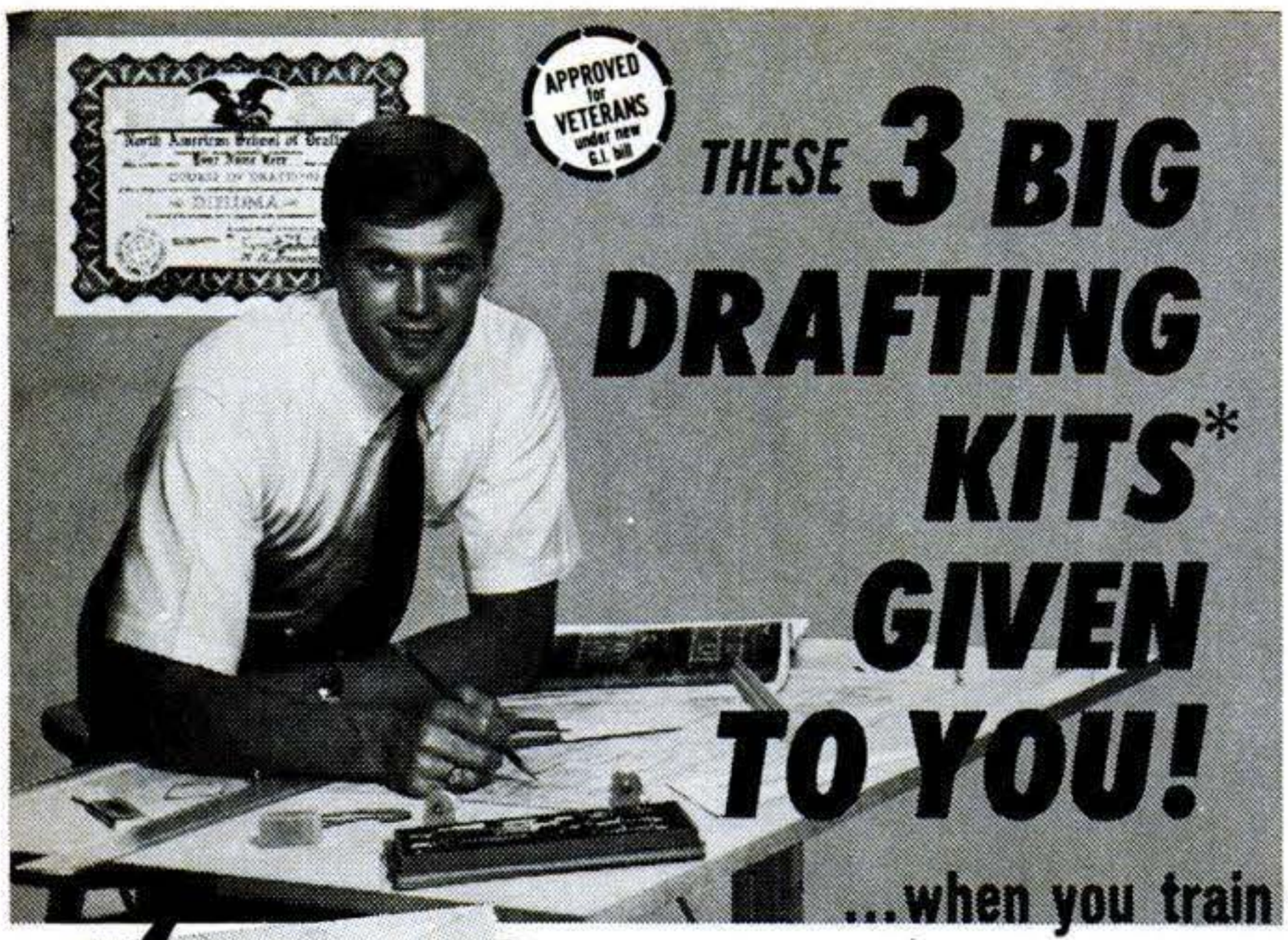

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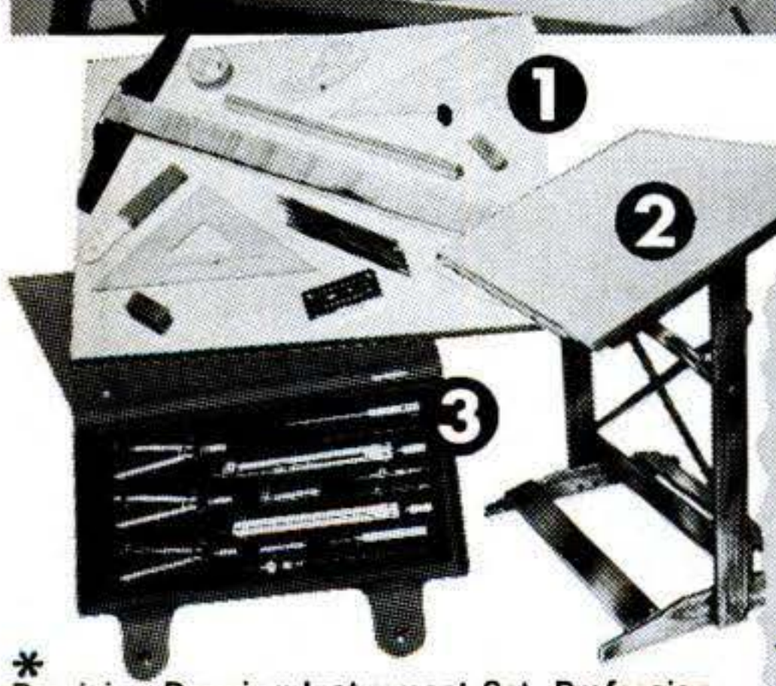

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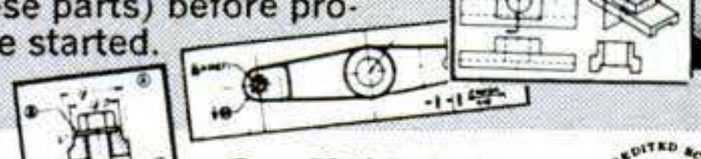

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[Continued from page 119]

sants, so powerful that they can dissolve and clean out engine deposits as fast as they form.

Can those cleansing agents make up for the oil that's left out of the lean fuel-oil mixture? Combined with improvements in engines that make lubrication more efficient, they can. Better bearings, better lubricant distribution, and improved piston rings have helped to make the 50:1 oils possible.

Idling on no oil. It has always been desirable to reduce the amount of oil fed into an outboard motor, for better low-speed performance. Since it's impractical to vary the oil ratio during operation, the proportion of oil is dictated by lubrication needs at top speed, when the engine is working hardest. At idling or trolling speeds, the excess oil fouls spark plugs, adds smoke to the atmosphere, and contributes to engine deposits. Tests have shown that an outboard motor can run satisfactorily at idling speed with no oil at all.

Outboard-motor engineers make a sharp distinction between the lean-mixture oils developed by the motor manufacturers and those formulated by the oil companies. In a recent research paper, G. E. Miller and H. M. Pollari of Outboard Marine said: "Heavy combustion-chamber deposits on both the piston deflector and in the cylinder head are prevalent when using most commercial outboard oils." Such oils often include detergents containing metals such as calcium, which combine with lead in the fuel to form tough deposits, rather than the more expensive nonmetallic or ashless dispersants favored by the motor companies.

The three major manufacturers, Outboard Marine, Kiekhaefer Mercury, and Chrysler, all promote their own 50:1 oils. However, an engineer for one of those manufacturers told me his company really didn't care which of the three brands a motor owner uses. "The three formulas are essentially the same," he said. "The important thing is to use a 50:1 oil made by a motor company."

Incidentally, the 50:1 recommendation is far from universal. Perhaps the richest mixture is the 10:1 recommended by British Seagull. For the smallest Chrysler and Montgomery Ward motors, 16:1 is recommended. Mercury still recommends 21:1 for older motors (pre-1963), but 50:1 for newer engines; while Outboard Marine advocates the use of its 50:1 oil in Evinrude and Johnson motors of all ages. McCulloch and Sears advise 100:1 with their special oil. Chrysler says a 24:1 mixture should be supplied to motors used in commercial, racing, and heavy-duty applications. Some racing mechanics play it very safe and feed a 10:1 or even 8:1 mix to specially tuned high-performance racing motors.

The differences should be taken seriously and applied with due regard for your investment in your motor, according to the engineers. Small motors with simple sleeve bearings, such as the Seagull, require more oil than those with needle bearings and the like. The theory that older motors have "loosened up" and can get along on less oil, is a myth, engineers say.

Today's oils mix better. The 24:1 recommendation that used to be widespread sometimes included a safety factor to allow for incomplete mixing of oil with gas; outboard oils today mix better, but plenty of agitation is still necessary. Premixed oil and gas helps in this respect, but you can't be sure what kind of oil goes into the mix. The 24:1 ratio is still regarded as a safe bet with oil of unknown quality, even if your motor will take a special 50:1 oil.

Can you tell, through your engine's performance, whether you're getting satisfactory fuel or oil? To some extent you can, the experts say. If the motor isn't running well, sometimes switching to a different oil or gas will produce a distinct improvement. Looking inside the cylinders can provide clues, but it takes experience to spot the difference between harmful deposits and the normal carbon coating on the piston crown.

If you're careless and don't follow the manufacturer's recommendations, serious problems can develop. These can sometimes build up until total failure of the power head develops. You can avoid such a crisis, however, by reading your owner's manual and getting advice from a qualified dealer. PS

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Gus Seals a Used-Car Bargain

Gus felt more like a secret agent than a mechanic as he kept a rendezvous to inspect a mysteriously ailing auto

By MARTIN BUNN

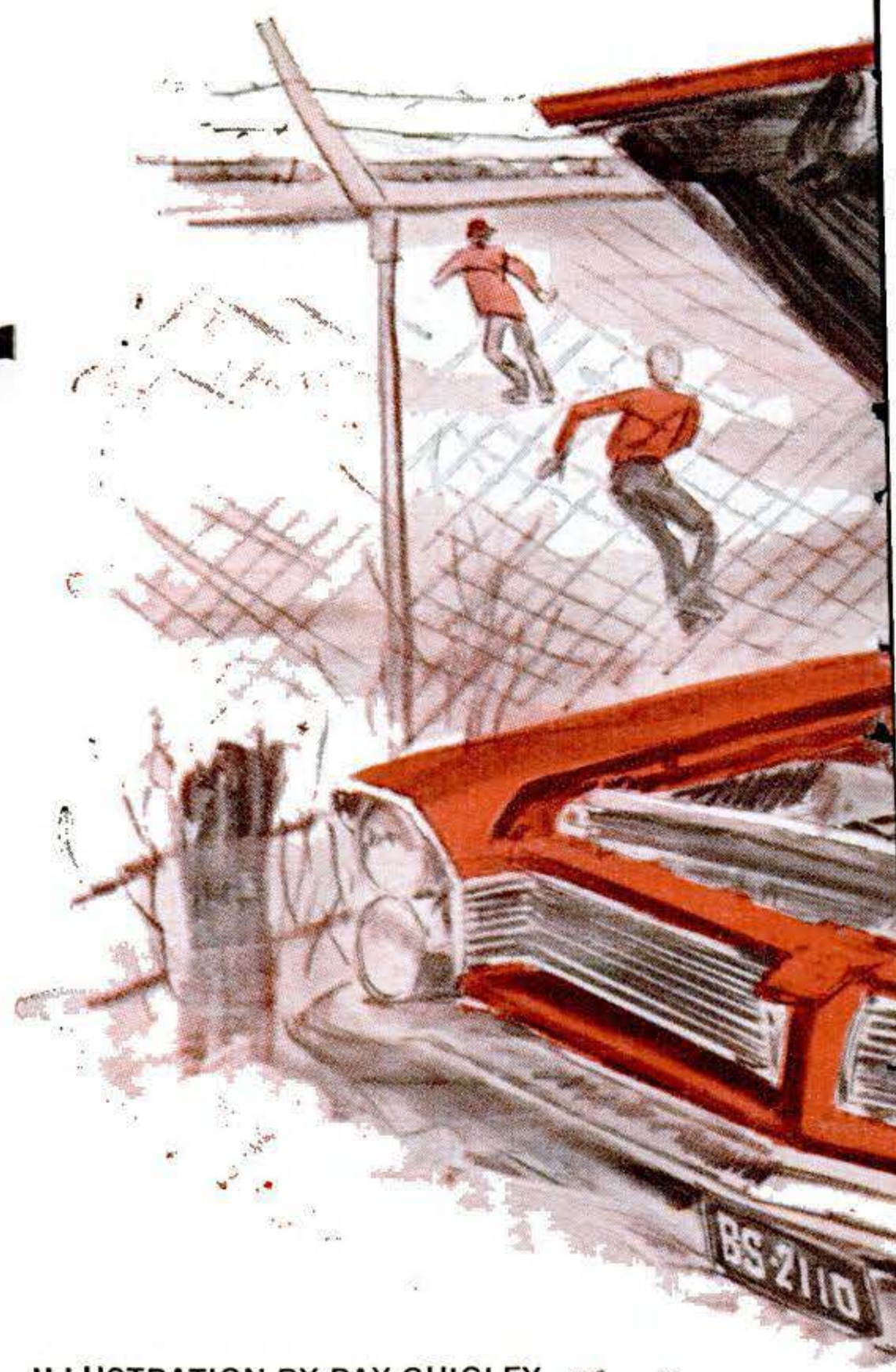

ILLUSTRATION BY RAY QUIGLEY

The loud crash of a falling stack of oil cans in the back room heralded the arrival of Pete Thompson at the Model Garage. It was lunchtime, and both Gus Wilson and his assistant, Stan Hicks, were in the office, munching sandwiches and sipping coffee, when they heard the clatter. A moment later, Thompson poked his curly-haired head through the office door.

"Sorry about the noise, Gus," he said. "I tripped." He nervously eyed Main Street through the big glass window. "I used the back door so that no one would see me come in. Can we talk for a few minutes—out back?"

"Sure thing, Pete," answered Gus. "But why is the front office off limits?"

"Because if Mr. Taylor, my boss, knew I came to see you, he'd fire me on the spot," Thompson said glumly. "He wouldn't appreciate his chief mechanic asking another mechanic for advice—especially about *the* car."

"You mean old man Harper's '63 Pontiac?" Stan asked.

Thompson nodded.

"Hah!" Stan exploded gleefully. "So you're ready to give up! I figured that sooner or later Gus would get a crack at it."

Outside, a car pulled up to the gas-pump island. Thompson ducked.

Gus chuckled. "Okay, Pete," he said. "If these cloak-and-dagger games will keep you happy, let's go back to the storeroom and chat while Stan takes care of the customers. At least it will give you a chance to restack those cans that you kicked over."

Stan jogged out to the pumps.

"It really boils down to a warranty problem," Thompson explained. "The used-car agency I work for issues a 90-day parts-and-labor warranty on any car that is in outstanding mechanical condition—Mr. Taylor calls them 'Tip-Top' cars in his ads. It's one of my jobs to decide which cars qualify."

"And you certified the '63 Pontiac that Mr. Harper bought?" Gus asked.

"Uh-huh," said Thompson. "It was in absolutely great shape when I examined it—less than a month ago. But about two weeks ago, the trouble started. When the engine is cold, it starts and runs perfectly. But after running a few minutes,

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Gus pressed the accelerator linkage, and listened carefully as the r.p.m. climbed to about 2,000. "Sounds perfect so far," he shouted over the engine roar.

it dies, and it won't start again until it cools off. Then it runs okay for another few minutes and quits. I'm stymied, Gus. The symptoms are always the same. We've towed the car in four times so far —it's in the shop right now. Mr. Harper wants his money back, and Mr. Taylor is boiling mad at me.

"You heard the way Stan talked earlier," he continued sadly. "Almost everyone in town knows about the car. It's no secret that my job is on the line."

Gus lit his pipe. "I can't do much by long distance," he said.

Thompson's face brightened. "I'm sure I can get the car to a neutral point—say, the ice-rink parking lot—running on its own power."

"It's a deal," said Gus. "Meet me there in a half-hour."

After watching Thompson skulk out the back door, Gus turned to Stan. "I'm going out on a road call. Any problems?"

Stan was bent over the tire-changing machine, wrestling with a heavy wheel, and the icy glare he shot back at Gus proved that that was the wrong question.

"I've demounted and remounted this darn tire twice already," he said, "and here comes number three."

Continued

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Harry Lyons was leaning, arms folded, back against the fender of his '67 Ford wagon, watching Stan work. He returned Gus's greeting with a grunt and held up a two-inch-long finishing nail.

"My expensive new radial-ply tires attract these things just like my old-fashioned cross-plies." His eyes narrowed. "Hope they don't cost any more to patch."

"Price is the same as always," said Gus. "Your new inner tubes are made of a special rubber designed to withstand the greater sidewall flexing of a radial tire, but an ordinary cold patch will handle any simple puncture."

"My wife got that one for being named Woman of the Year by the National Association of Body and Fender Men."

"There's nothing simple about this puncture!" said Stan. "I'll show you what I mean."

He dripped a few dollops of soapy water around the base of the valve stem. "See the bubbles?" he asked sourly. Gus nodded.

"Somewhere near the base of the stem there's a pinhole leak, but I can't find it. I partially inflated the tube outside of the tire, and dunked it in the water tank, and nothing—no bubbles, no hiss, no pinhole. But as soon as I put it inside the tire again, it starts to leak."

Harry Lyons tapped Gus's shoulder. "That valve was okay when I drove in. The nail was clear around on the other side of the tire."

Gus looked questioningly at Stan, but Stan just shrugged his shoulders.

"I'll say one thing," Lyons added. "These tires may improve road-holding, but my old tubeless tires were sure easier to mend."

It was the word "tubeless" that did it. Gus and Stan looked at each other, and almost with one breath said, "There is no leak."

Gus explained the mystery to Lyons as he bolted the wheel in place.

"This wheel is designed for tubeless tires, so all of its internal seams are airtight. What's more, even though this radial-ply tire is a tube-type design, its bead is able to form an almost airtight seal along the wheel rim.

"This means that when Stan mounted the tire on the wheel, a lot of air was trapped inside. Then, when he inflated the inner tube, this trapped air was compressed between the outside of the tube and the inside of the tire. It's leaking out slowly past the valve stem, since the stem base doesn't form a perfect seal to block off the valve hole in the wheel. The hissing and bubbling will stop when the trapped air is all expelled."

The Harper Pontiac sedan, hood raised, was parked in a secluded corner of the ice-skating lot when Gus arrived.

"I figured the engine would lose heat faster with the hood up," said Thompson. "You'll want to see the whole cycle, beginning with a cool engine."

With Gus peering intently at the engine, Thompson hit the starter switch. The big V-8 spun to life and settled into a silky-smooth idle. Gus pressed the accelerator linkage, and listened as the r.p.m. climbed to about 2,000.

"Sounds perfect so far," Gus shouted. "Hold it at this r.p.m. for a few minutes."

Suddenly—without any rough-running warning—the engine died.

Gus whistled softly. "She quit cold—as if you flipped the ignition switch off."

"Yeah," agreed Thompson, "and it'll stay off. Watch." He worked the starter, but the engine wouldn't catch. It cranked at normal starting speed without even a cough. Gus straightened up, a puzzled expression on his face.

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"I know exactly how you feel," said Thompson. He slid out of the driver's seat and slammed the hood shut. He reached into his shirt pocket and took out a slip of paper. "Here's a list of the fixes my shop tried—none worked."

Gus scanned the list quickly: "Rebuild the carburetor . . . overhaul fuel pump . . . replace ignition wiring, points, and plugs . . . check fuel line . . . check valve tightness, test PCV valve . . ." The items went on and on.

"Did we miss any bets?" Thompson asked.

"Doesn't seem so," replied Gus.

"There goes my job," Thompson said.

Gus was too lost in thought to respond. "It's got to be an electrical problem," he muttered. "The questions are how and where. Let's think about where."

"Right," said Thompson. "I'm willing to try anything—even thinking out loud."

"The trouble is closely related to engine temperature," Gus said. "What components of the ignition sytem are mounted on the engine, besides the plugs?"

"The coil and the distributor," said Thompson, "but my shop assistant tried a replacement coil, and I personally checked every part of the distributor, from rotor to vacuum advance . . ."

"Lift the hood again," Gus interrupted. "I spotted something."

Gus's practiced eyes raced across the top of the engine for a moment, and settled on a small puddle of oil just below the distributor. He pried loose the distributor cap, and rubbed a finger along the breaker-point assembly surfaces.

"Crank the engine, Pete," he said. "And keep cranking until I say stop."

With the starter motor spinning the engine, Gus waited about 30 seconds, until the oil pressure had built up. Then he stared into the distributor.

A steady stream of oil droplets had begun to spin off the distributor shaft.

"There's your answer," he said. "Oil. Engine oil is a good electrical insulator. The seals on the distributor's drive shaft are bad. When the engine warms up—and the oil thins out—oil squeezes by the seals and ends up on the shaft. Some of the oil droplets that are spun off hit the breaker points, coating them with a thin, insulating oil film."

Thompson nodded, "And the film interrupts the ignition current, so the engine dies."

"And it won't start again," Gus added, "until the oil cools down enough and thickens so that there's no more oil leakage past the seals. When the droplet spray stops, the hammering action of the point surfaces pound through any remaining film, and the ignition current can flow again."

Gus chuckled for a good part of the drive back to the Model Garage. He was thinking of the note in his pocket:

"Dear Gus: My chief mechanic Pete Thompson has too much pride to admit he can't solve an auto problem all by himself. I don't dare suggest he ask you for help, since he might up and quit. He's too valuable to risk that.

"Can you drop by this afternoon for a 'social call' and peek over his shoulder, and maybe give him a helpful hint? Whatever you do, though, don't tell him it was my idea. Lou Taylor." PS

European-made baby "dream car" features wind-cheating contours

This 13½-foot-long Opel GT 1900, made by General Motors in Germany, is sculptured to cut wind resistance and add aerodynamic stability, from disappearing headlights to ducktail rear. With a 102-hp. engine, the little two-seater will go from zero to 60 in 11.5 seconds. Drive to the torque-tube back axle is via a four-speed, all-synchro box.

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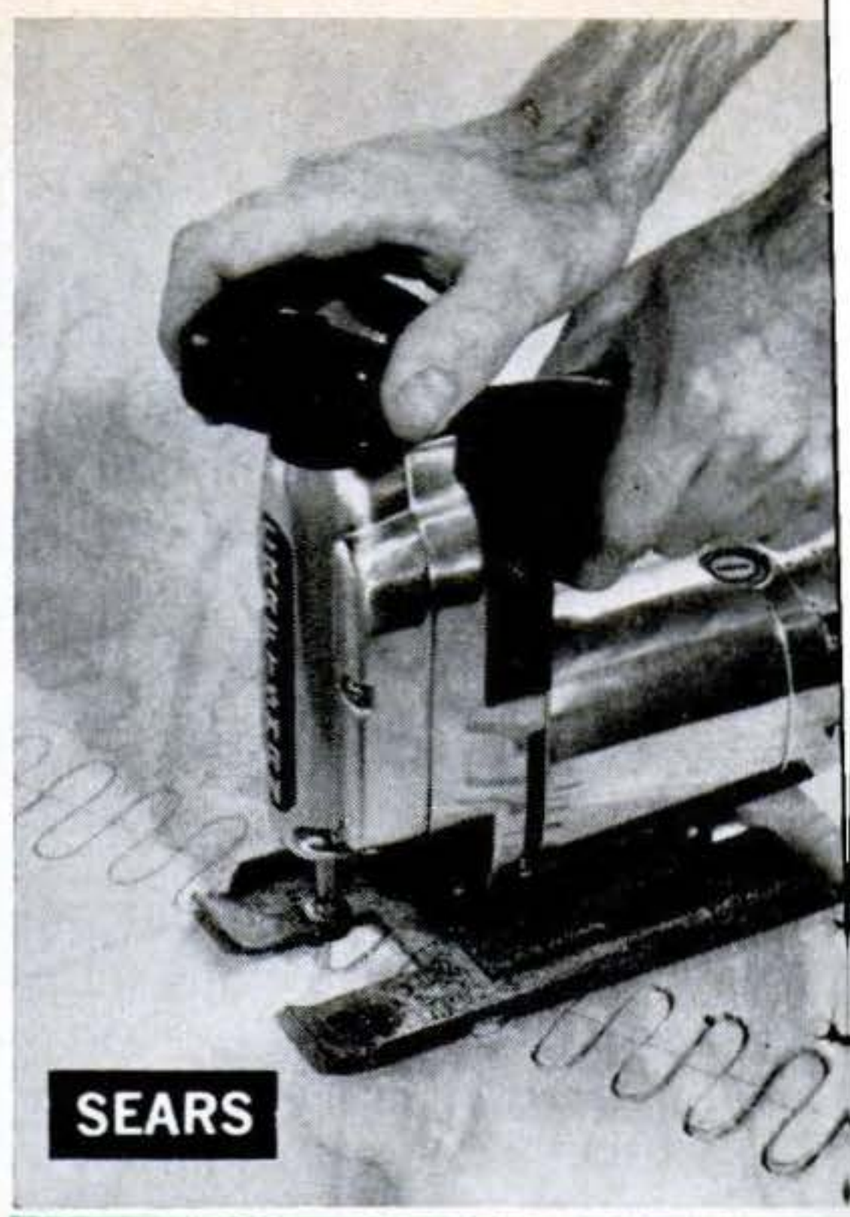


How they drive a spindle that is free to revolve

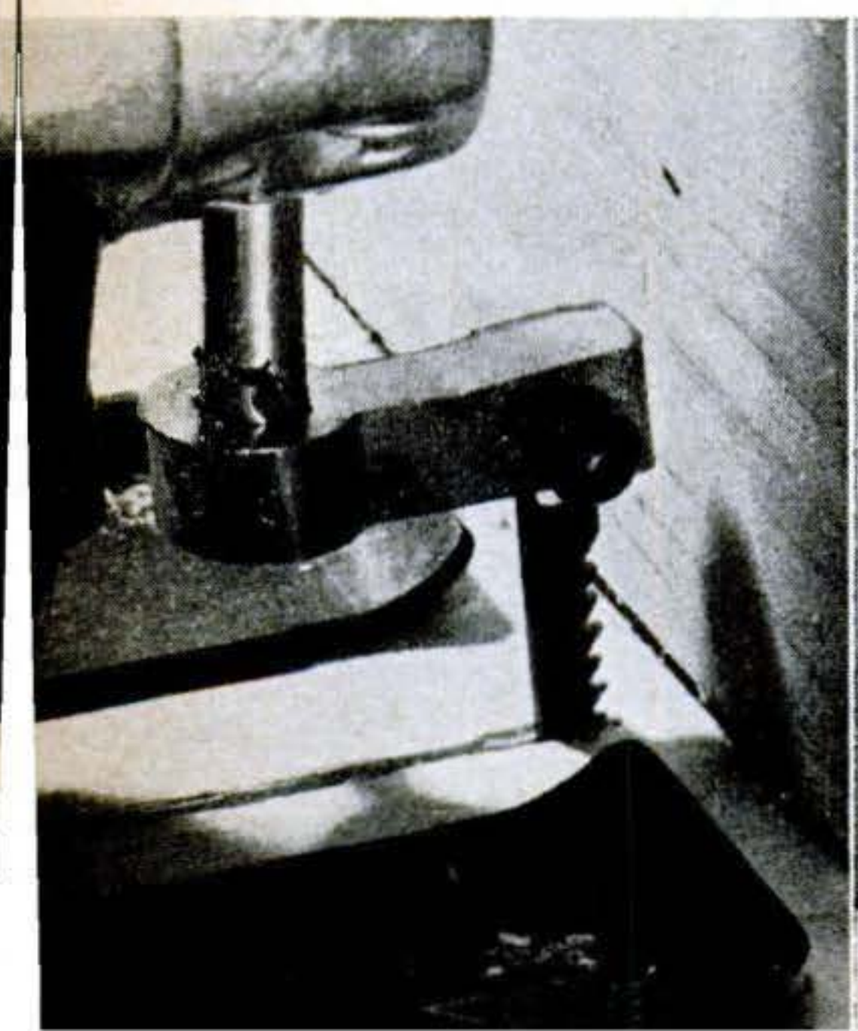
Principle of operation, in sketch far right, is based on Sears gearbox, opened to view (we didn't have a Thor to check). Motor spindle at bottom of housing drives two cam gears with projecting studs that engage slots in blocks on the blade spindle. Top block is

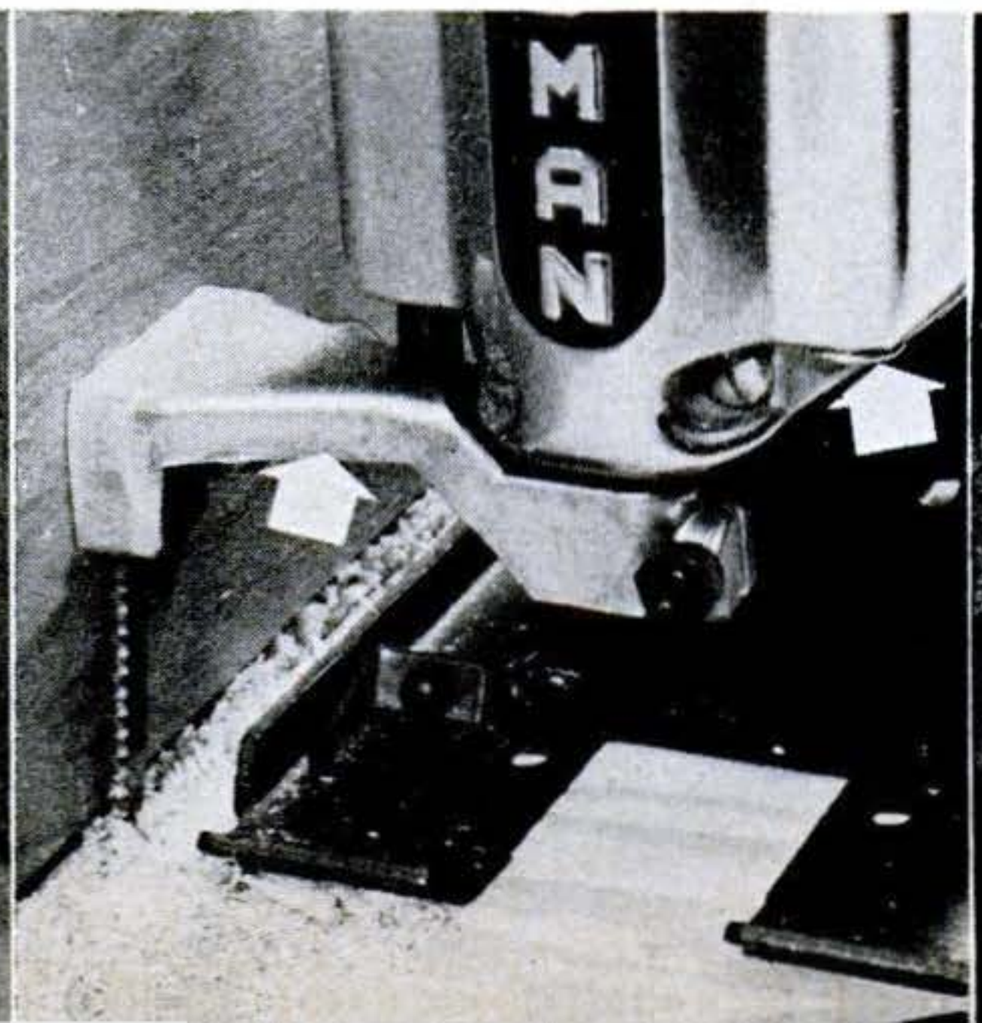
New Twist in

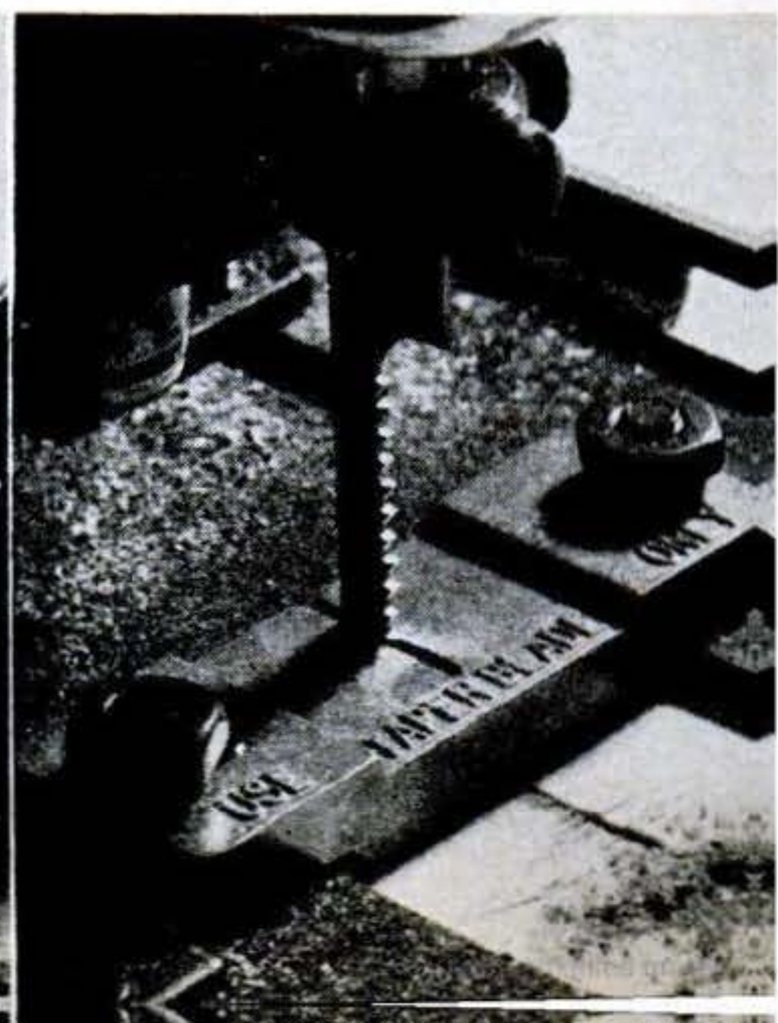
Flush-cut accessory moves blade out ahead of the shoe so you can cut to about 1/8 inch from a vertical obstruction. It's about $2 extra. Blade spindle must be locked in forward cutting position.

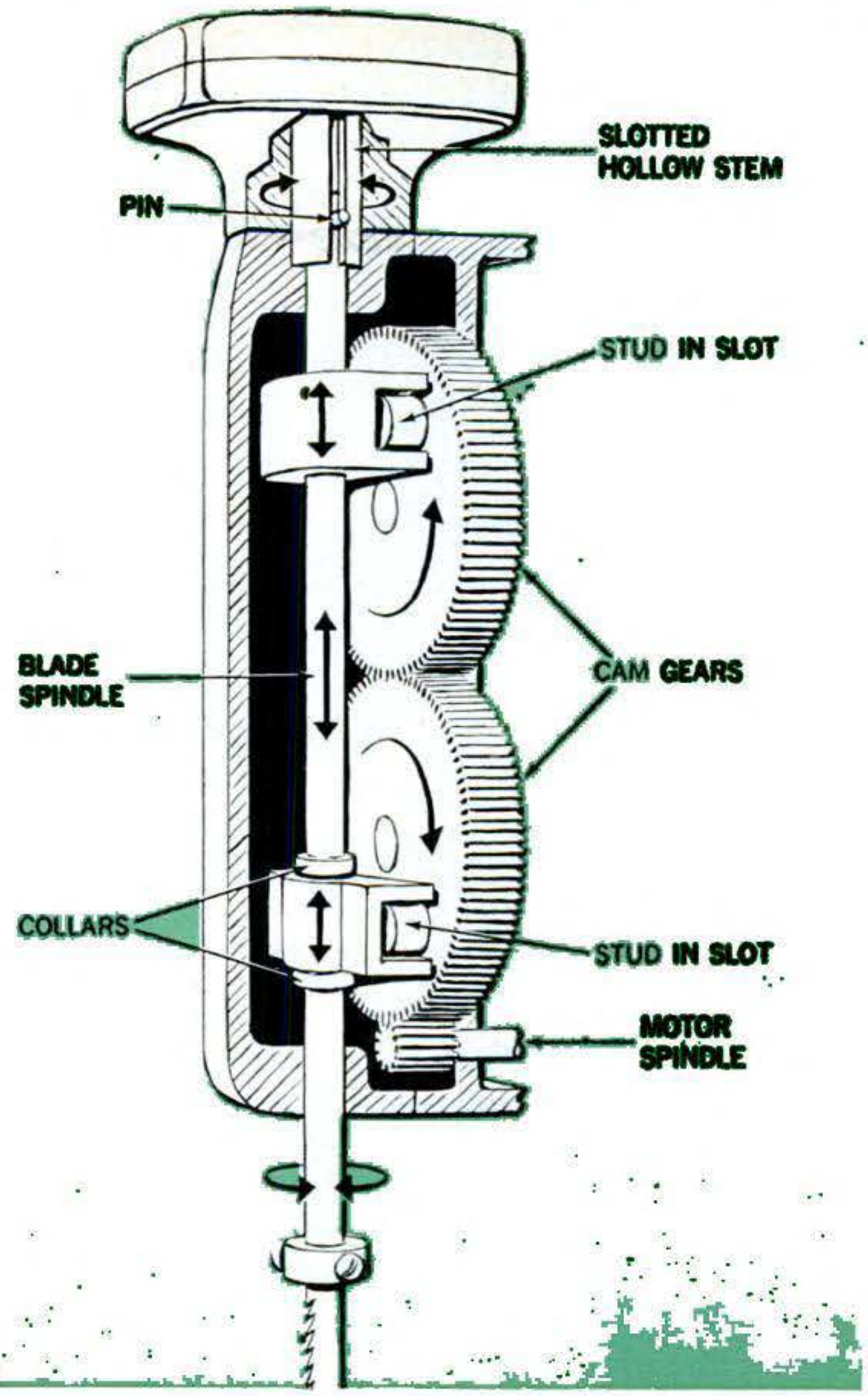
Side-cut accessory mounts on either side of saw, moving blade outside of shoe. About $5. Extra spindle stub (left arrow) rides in special sleeve. When not in use, sleeves are capped (right arrow).

Splinter-free attachment is speci.i: plate slotted to fit a tapered, no-sea blade; both come with the save Plate rides directly on work, pr venting splinters on upstroke. can be mounted with slot forwaro









loose on spindle, so acts only as counterbalance to dampen vibration. Bottom block turns on spindle but is held in place by two collars. Bottom gear drives spindle up and down, yet spindle is free to turn. Knob has slotted stem in which top of spindle rides. When knob is turned, pin through spindle follows slots; spindle continues up and down as it turns.

Portable Jigsaws

Two models now let you turn the blade instead of the body, to do precision jobs never before possible

By JACKSON HAND PHOTOS BY THE AUTHOR

You're about to change your entire idea of what a portable jigsaw is—what it will do and what it won't do, where you can use it and where you can't.

The new Sears Craftsman Multi-Speed Scroller Saw, already on the market, and the new Thor Roto-Blade SpeedSaw, due to reach stores about the time this article appears, are like no jigsaw you ever used.

The big news from both Thor and Sears (and there may be others coming along) is a spindle that you can rotate by hand while the saw is running. You don't have to turn the whole machine to turn a corner or follow a curve. You just turn a knob on top, and you have a slicker-handling, more-accurate saw than you ever had before.

But this fine-line accuracy is less than half the story. Since you can turn the blade to cut in any direction with the

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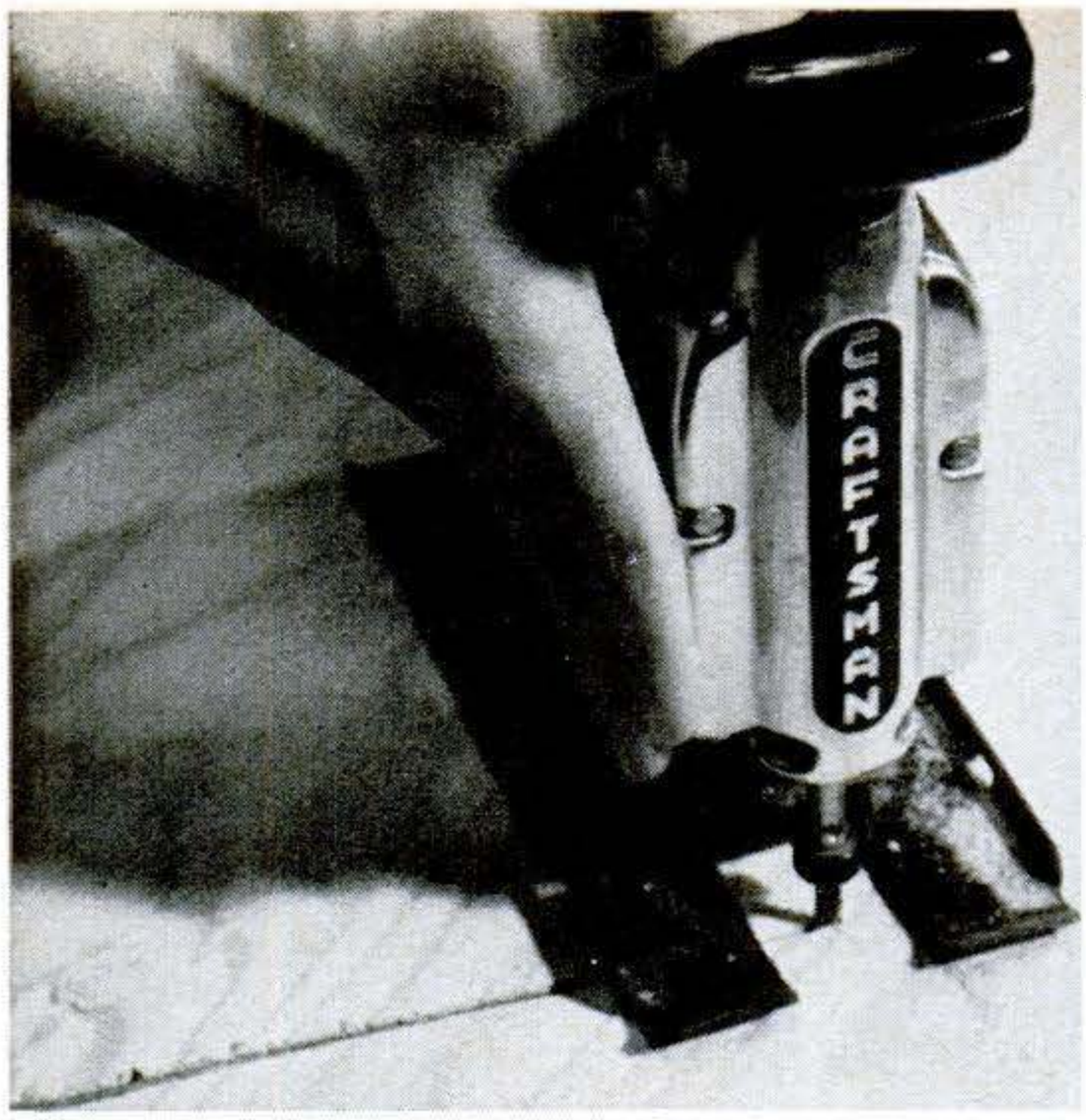
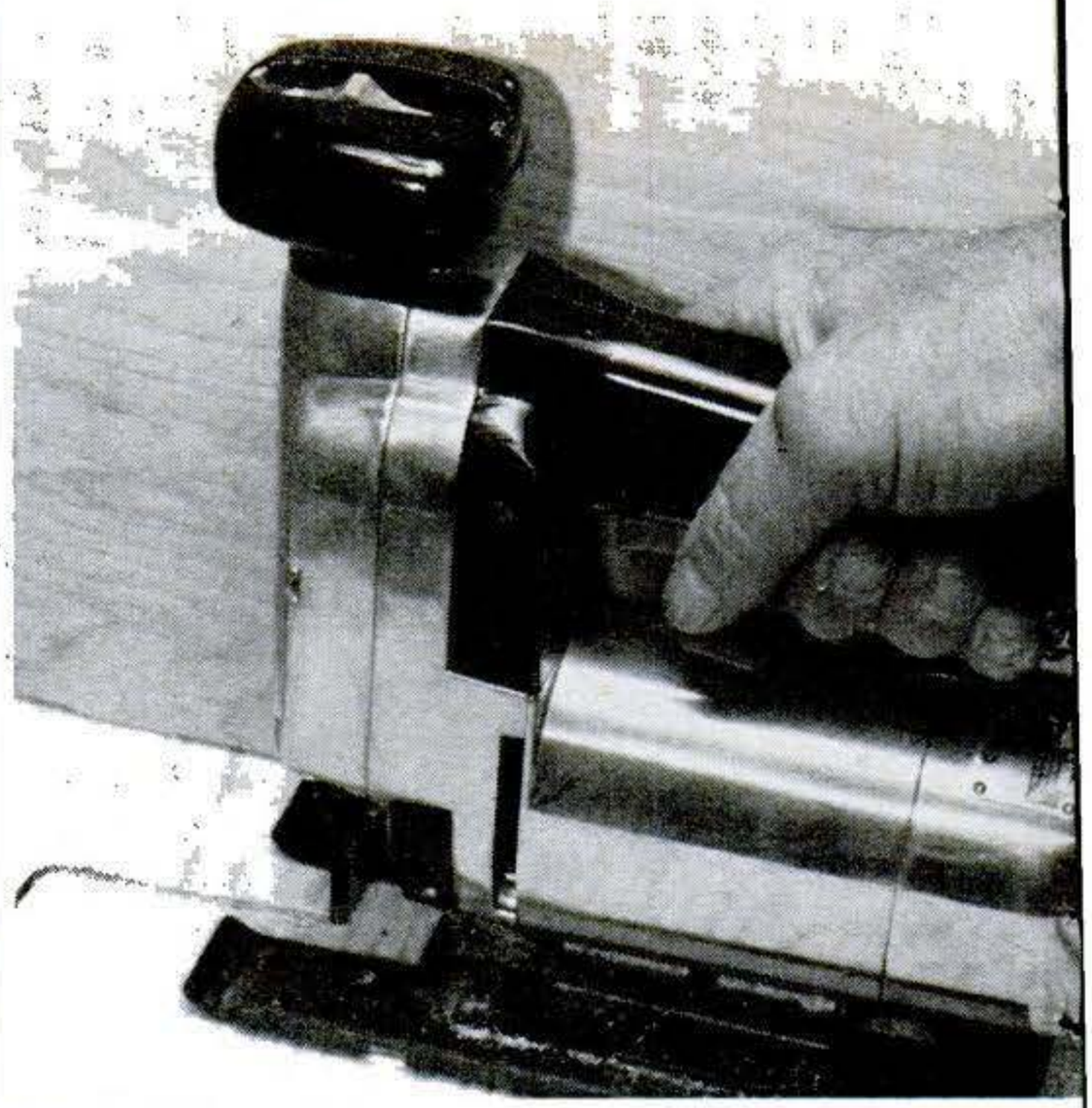


To move saw when blade is set for side cut, you exert pressure on side of housing. Sears Craftsman (shown in all photos here) locks at 90-degree points. Blade of Thor SpeedSaw can be locked at any angle.



Tight corners point up major advantage of turnable blade. Cut above was made sideways into corner, then blade turned in tight radius so teeth face rear. Saw is now backing out—often easiest way to cut.

bulk of the rig pointing in any other direction, you can run these new saws into corners and tight spots that were always out of reach for any power saw. Add to this some attachments Sears has for mounting the blade an inch or so in front of or to either side of the spindle, and you can match the close-quarters work of a hand-operated saw.

What took 'em so long? One of the first questions you're likely to ask is: Why was this rather obvious, badly needed improvement so long in coming? It's surely no earth shaker, as far as engineering goes. Our sketch shows what it took to do it.

Any jigsaw converts the rotation of the motor into an in-line up-and-down motion by means of a stud riding in a channel that's anchored to the blade spindle. All Sears did was to let the channel turn on the spindle.

On the Thor saw, the blade can be locked at any angle; it locks in forward, backward, and to either side on the Sears rig. (You can cut backwards with most ordinary saber saws by merely mounting the blade backwards. For straight or gently curved cuts, you'll often find it easier to pull the saw backward than to push it.)

Wide range of blades. Sears makes eight different blades available for the new saw. They include standard-set blades with teeth ranging from seven to 32 per inch, but there are some specialized blades, too:

- For fine cutting with a minimum of tooth marks and splintering, a tapered-back blade with no set. It cuts smoothly in wood, plastic laminates, hardboard, plywood, and the like, and it's the best choice for most plastics such as acrylic, polystyrene, and polyethylene.
- For fast, rough cutting, a three-point monster that makes a portable jigsaw sensible for cutting framing lumber, even up to four-by-fours. The blade is recommended for logs and branches up to five inches in diameter.
- A knife blade, for cutting soft rubber, leather, paper, cardboard, nonrigid plastics, insulation board, and all other materials you'd normally attack with a knife instead of a saw.
- A 32-point saw, fine enough to use on sheet metal.
- A small blade for fine scrollwork, allowing turns as tight as $\frac{3}{16}$-inch radius. With this blade, knob steering really proves its value, for turns that tight are nearly impossible when you have to swing the entire machine.

Most of the Sears blades have another useful feature: Their shanks are straight —not offset—and if you break a blade

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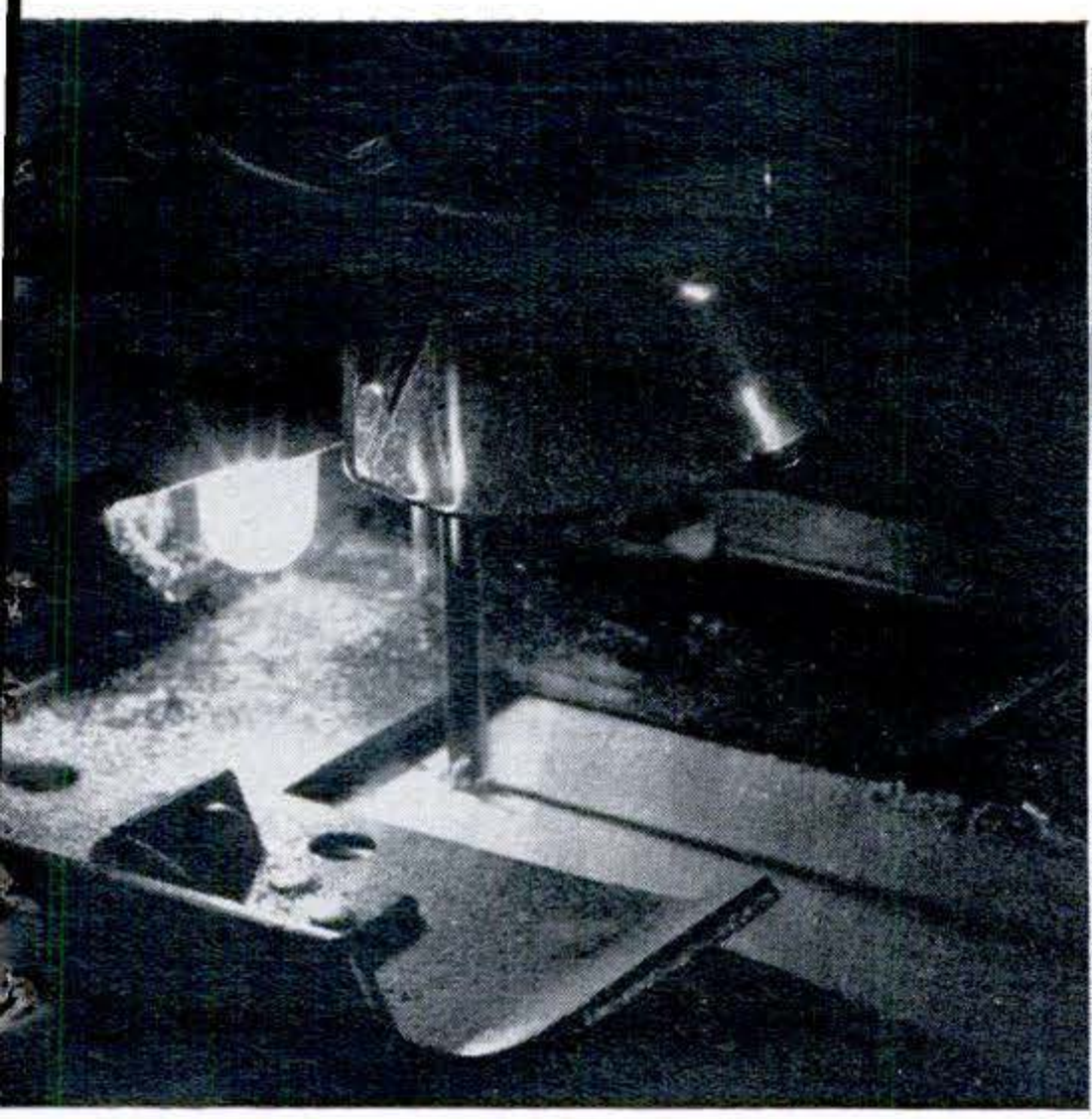
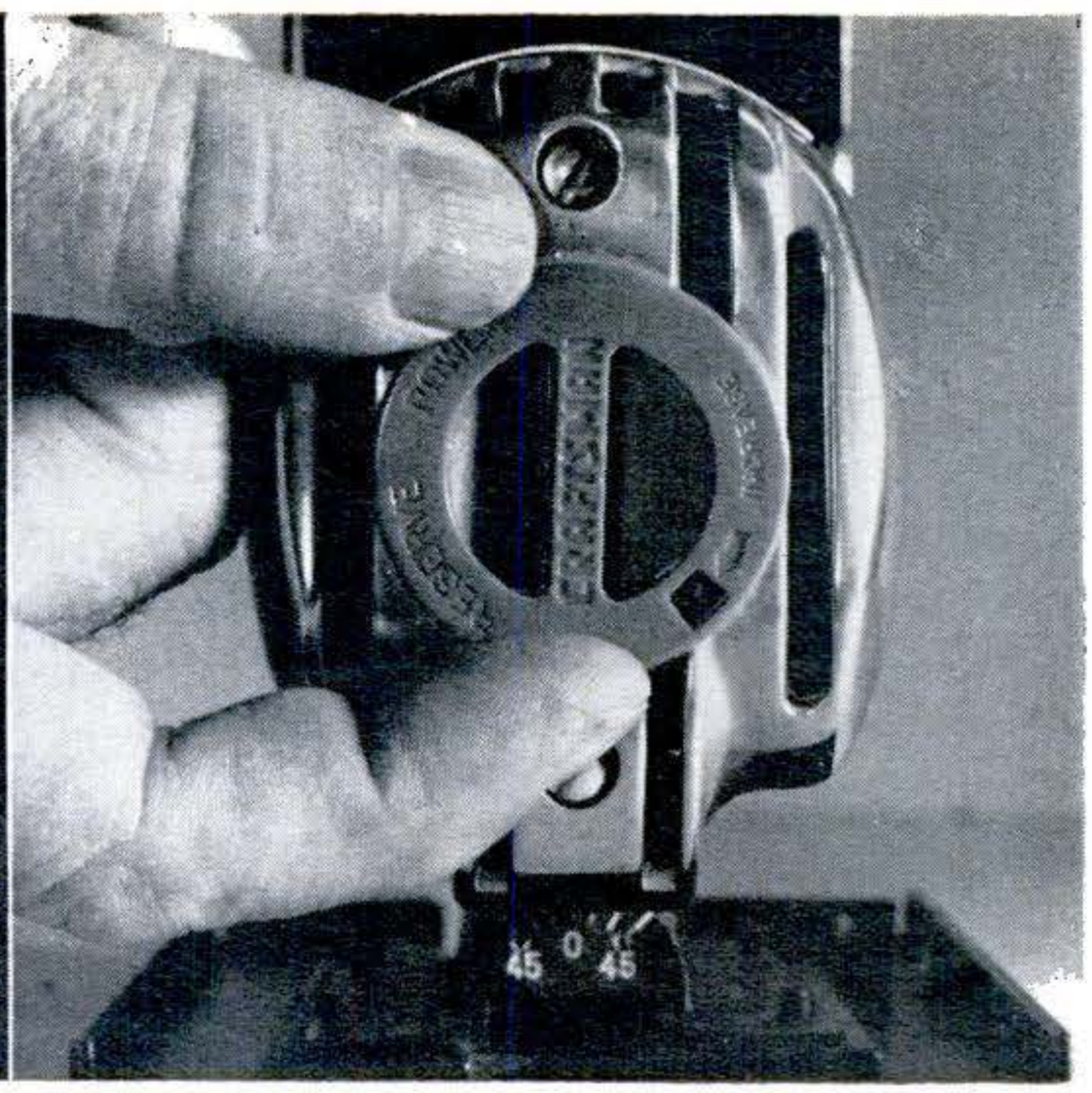


Light comes on when saw starts—handy in those dark, tight corners. Note clip-on guard of clear plastic that lets you watch cut. Also standard is an air jet to blow sawdust from the cutting path.



Speed adjustment ranges from 1,000 to 3,000 strokes per second, adjusted with dial on back of housing. Numbered positions show through window (at tip of finger), but speed change is continuous.

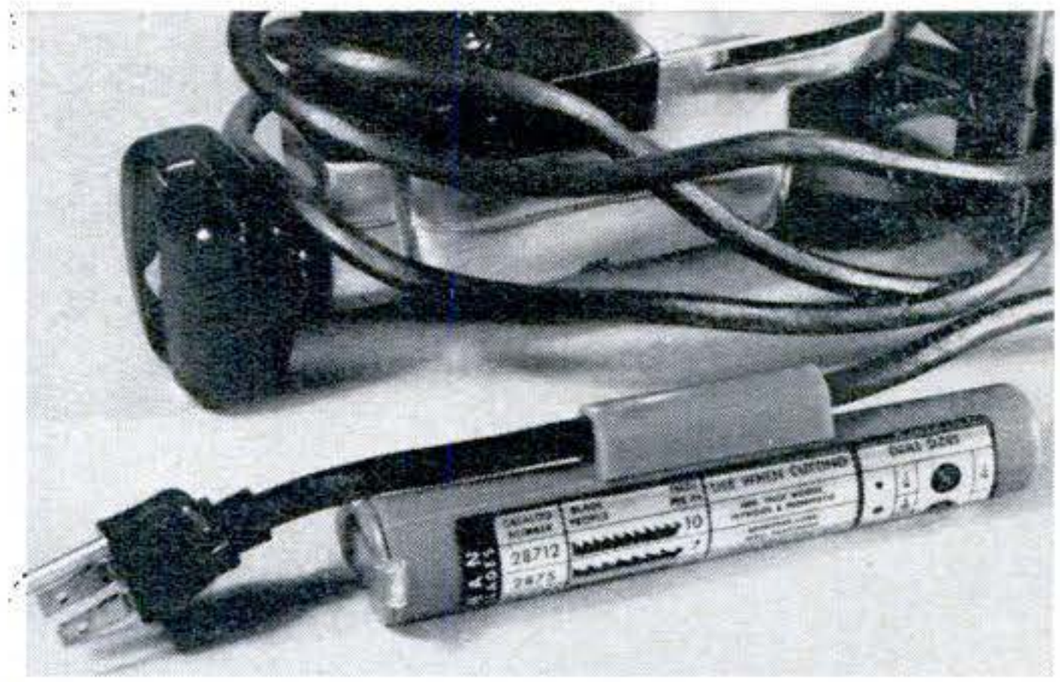
you can usually remove the stub, reinsert the blade, and go on with the job. Sears calls the blades "universal" and says their shanks will fit all saber saws. A clever, convenient blade-storage gadget is a plastic container that fastens on the cord.

The Thor SpeedSaw comes with two wood-cutting blades—seven- and 14-tooth. Also available are four-blade packets of 10-tooth blades for wood and 14- or 32-tooth blades for metal.

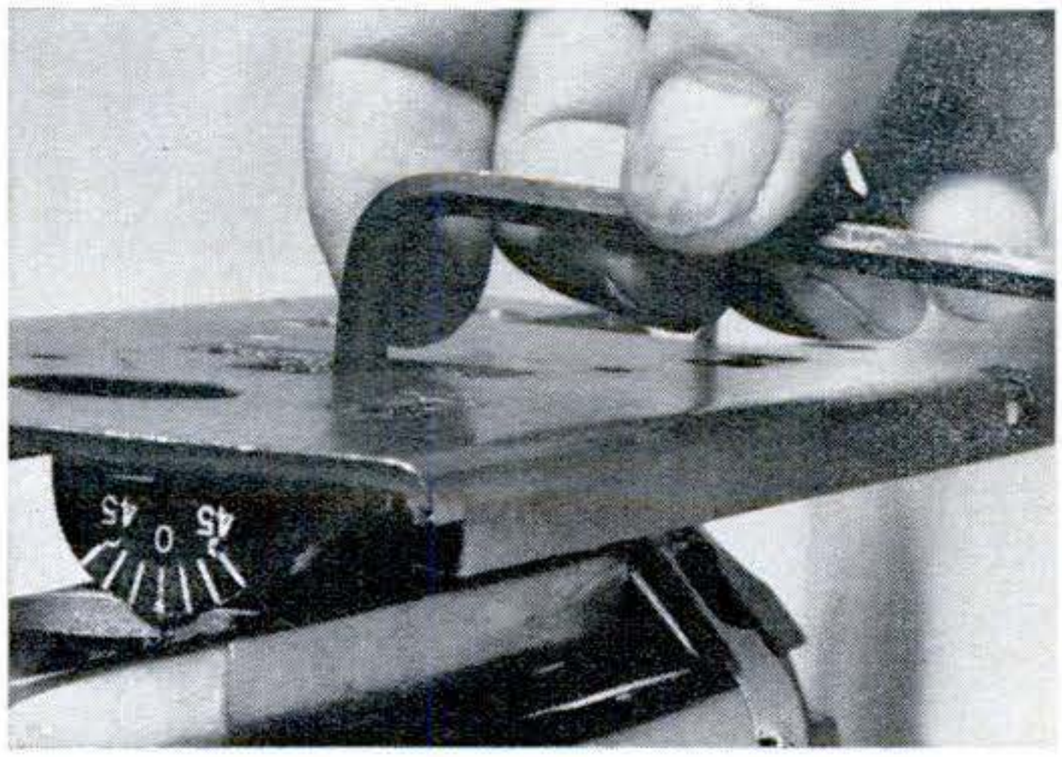
Variable-speed control. The Sears jigsaw has speed adjustments from a slow of 1,300 strokes per minute up to 3,200, in a continuous range. The change in speed is made with a dial at the back of the motor housing, and although there are numbered stations from 1 through 12, they signify nothing—although they might help you remember which setting you used the last time. As with standard variable-speed saws, you select speeds on the following guidelines:

- Slow speeds to start any cut, to make sure you're headed right before you go too far.
- High speeds for most work in wood, to insure the smoothest cut—although sometimes slower speeds produce less chipping.
- Medium speeds for thin metal. If the blade heats, use a slower speed; if

[Continued on page 207]



Blade storage is cleverly provided for with plastic tube that clips to the three-prong safety cord. Number, description, uses, and drill size for pocket cutting are shown on chart on outside of this tube.



For angle cuts, you adjust the position of the shoe, using an Allen wrench to loosen and tighten. Quadrant between shoe and housing gives you angles between zero and 45 degrees, both left and right.

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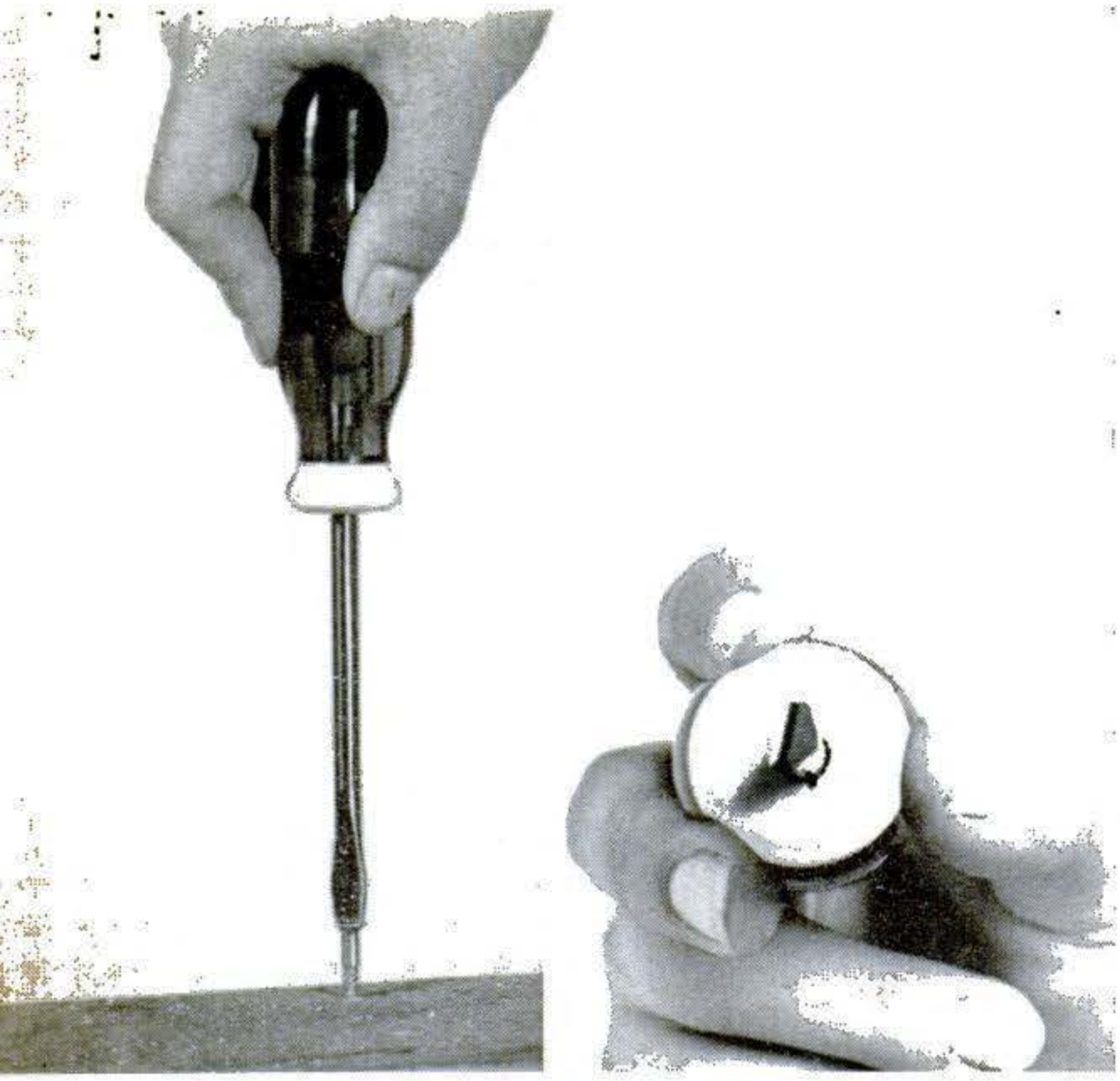
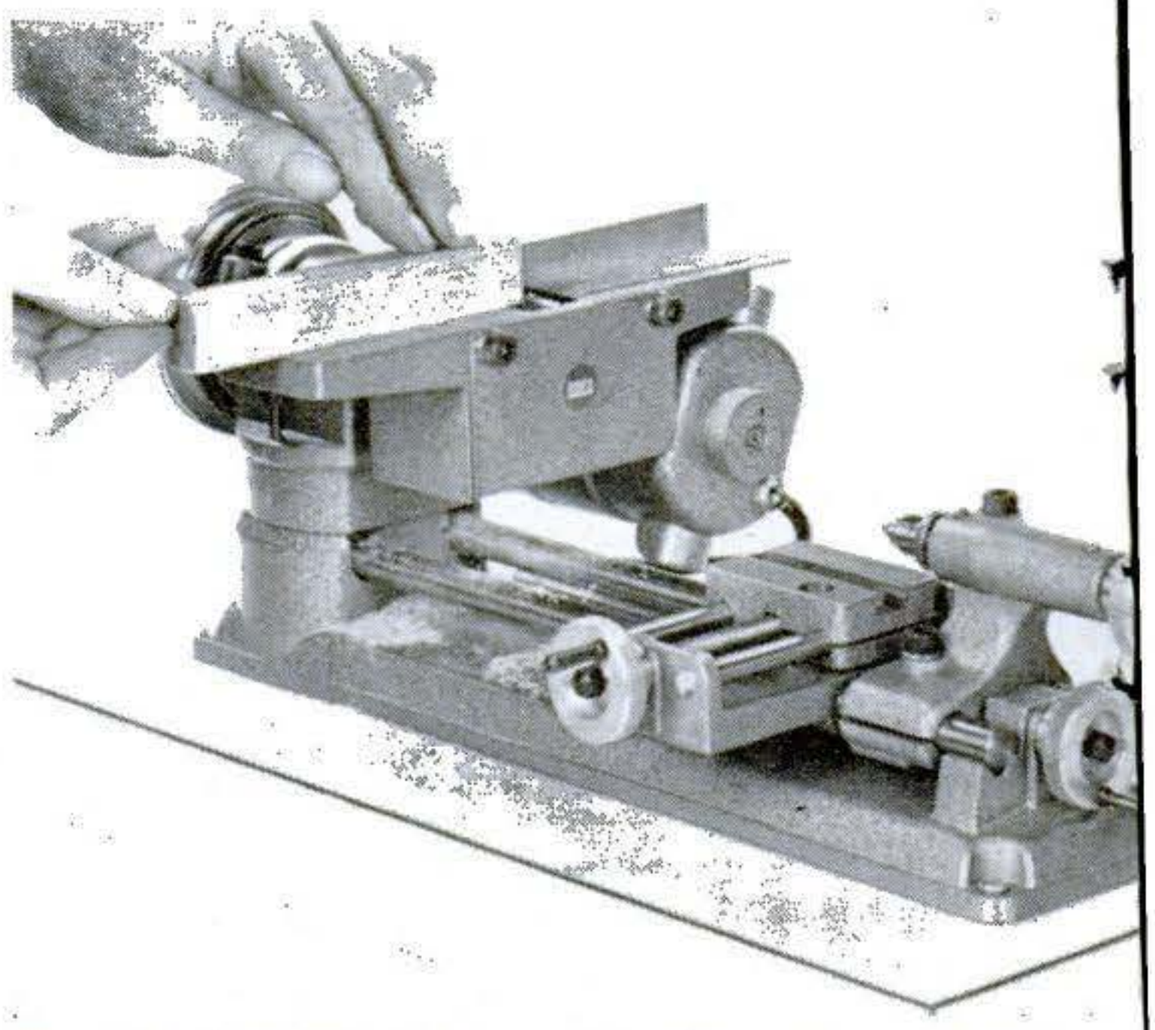
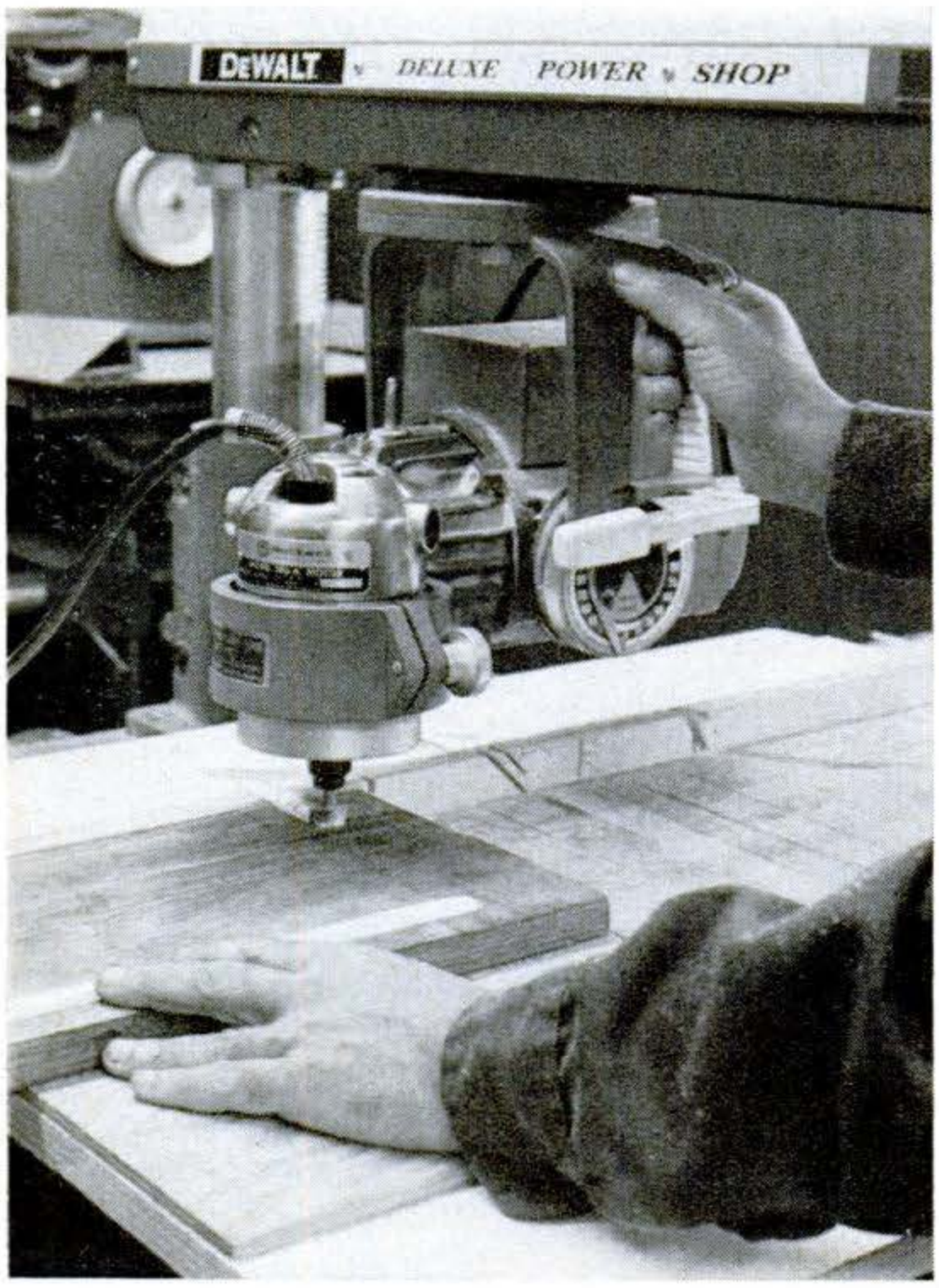
WHAT'S

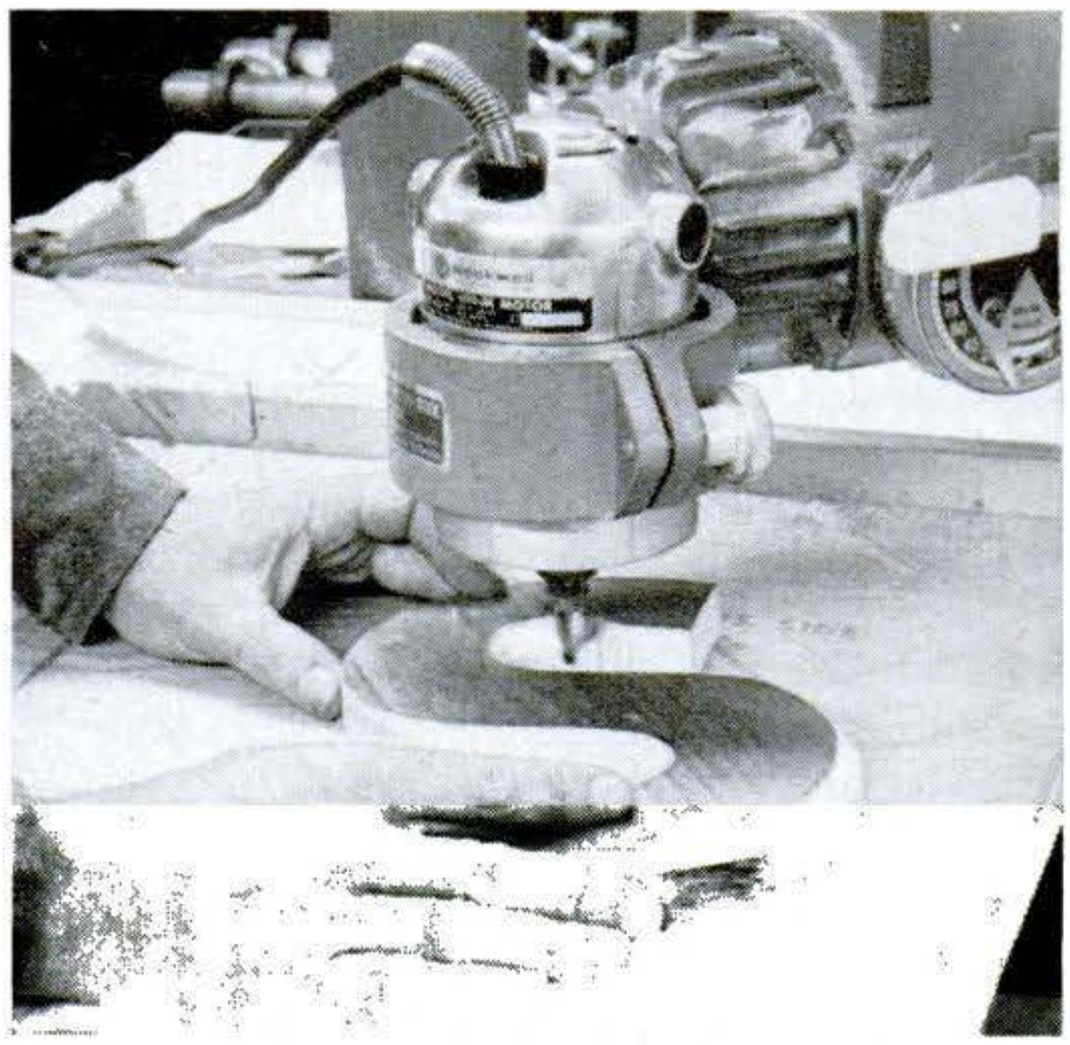


Improve the screwdriver? The challenge has been met by The Stanley Works: They redesigned the handle to give greater comfort and increase torque. Available in a range of sizes for both slotted and Phillips screws, the new tool has three wide grooves the full length of the handle (inset) to insure a non-slip grip for thumb and two fingers when driving or backing out stubborn screws. 89 cents to $1.85.



Planing attachment for multipurpose Unimat adds yet another function to this miniature metal lathe. An eight-inch table clamps on the headstock and adjusts for depth of cut; a steel blade with two sharpenable one-inch cutting edges screws onto the spindle and planes up to one-inch stock as smooth as you could sand it. Unimat, $139.50; attachment, $19.95. American Edelstaal, 350 Broadway, NYC.





High-speed routing on your radial-arm is now practical with this aluminum collar that fits most portable routers and clamps on DeWalt and Delta 9- and 10-inch saws (it's easily modified to fit others). Sawhead tracking and angle settings give you an overhead router you can move into the work (left) or lock to move the work against it (above). The Hit adaptor is $19.95 from Home & Industry Tool, 2 Merle Ave., Oceanside, N.Y. 11572. To order, give model of saw and router.

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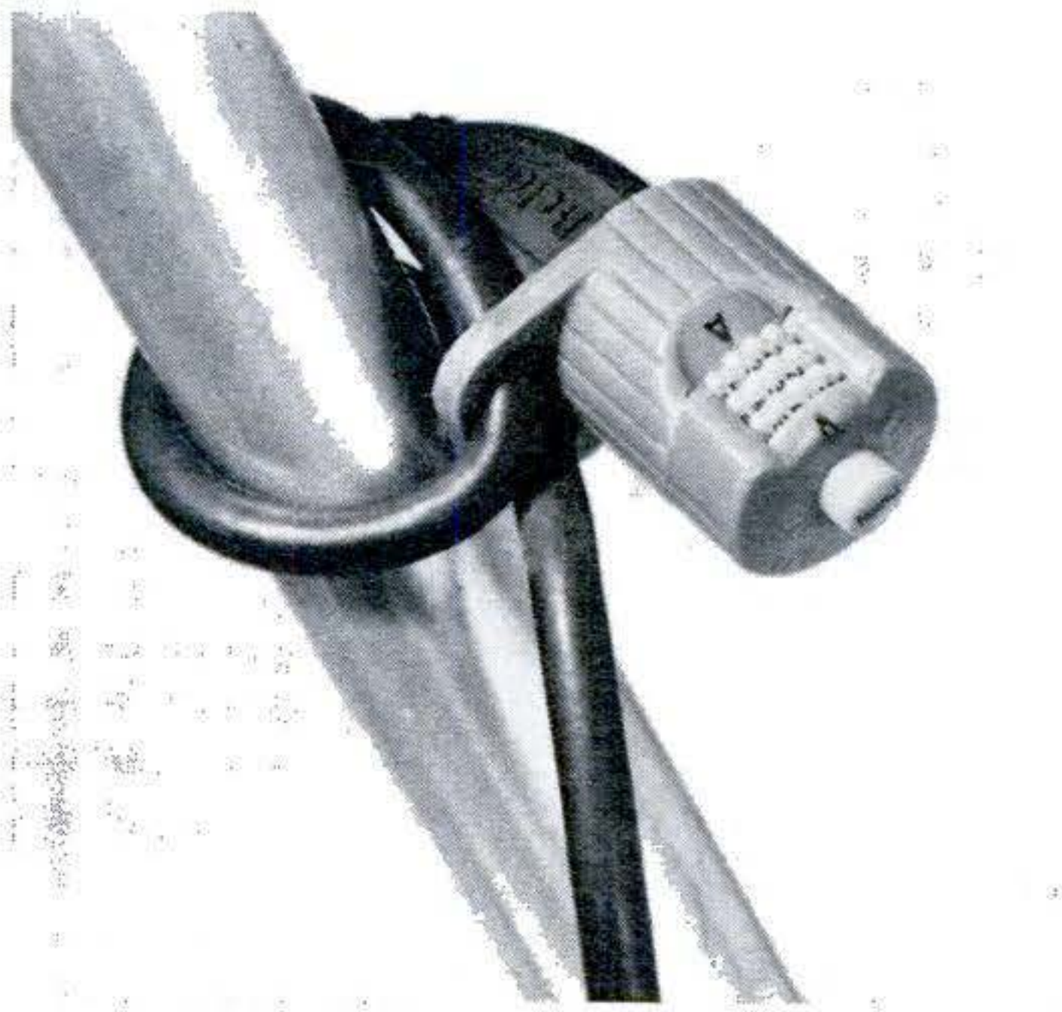
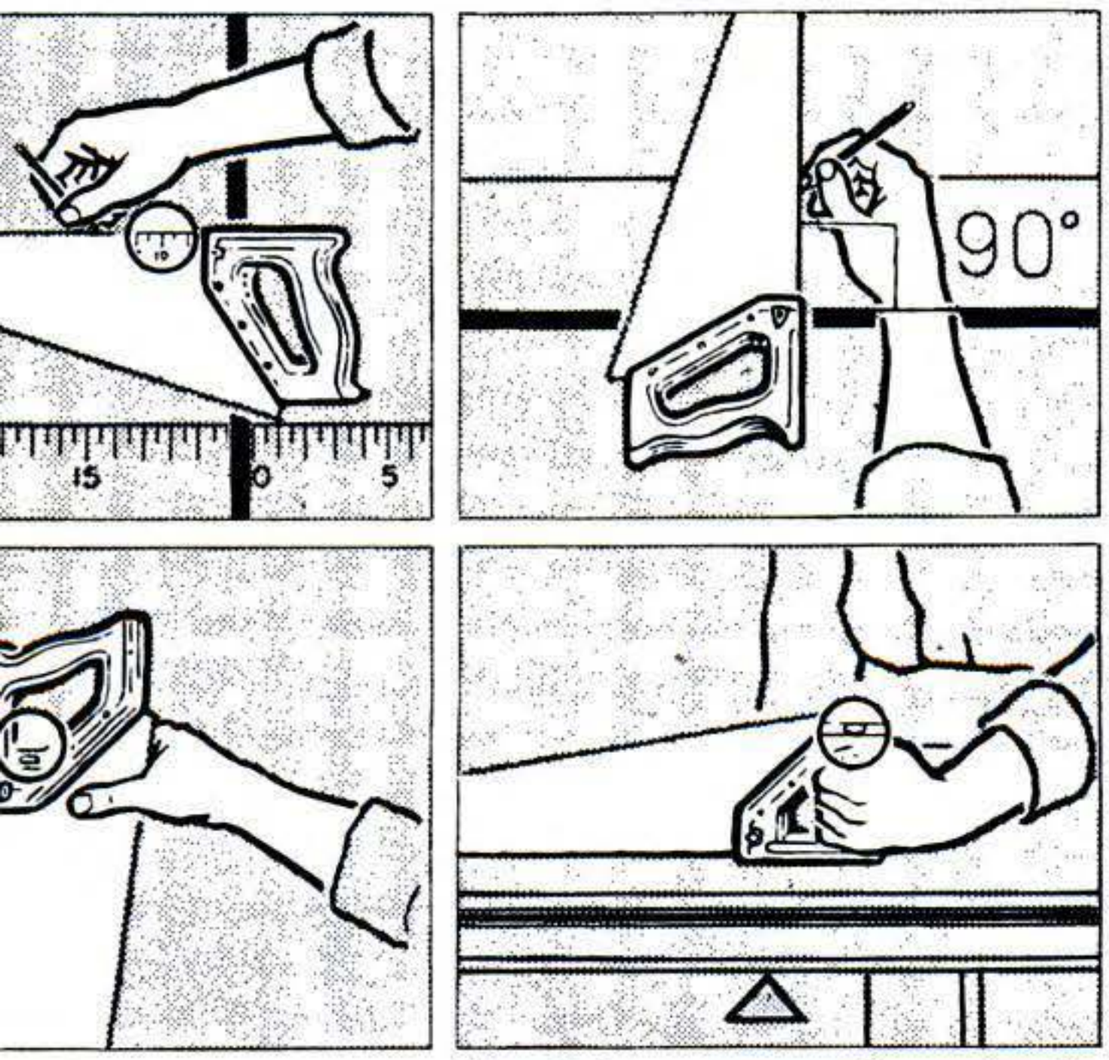
NEW IN TOOLS

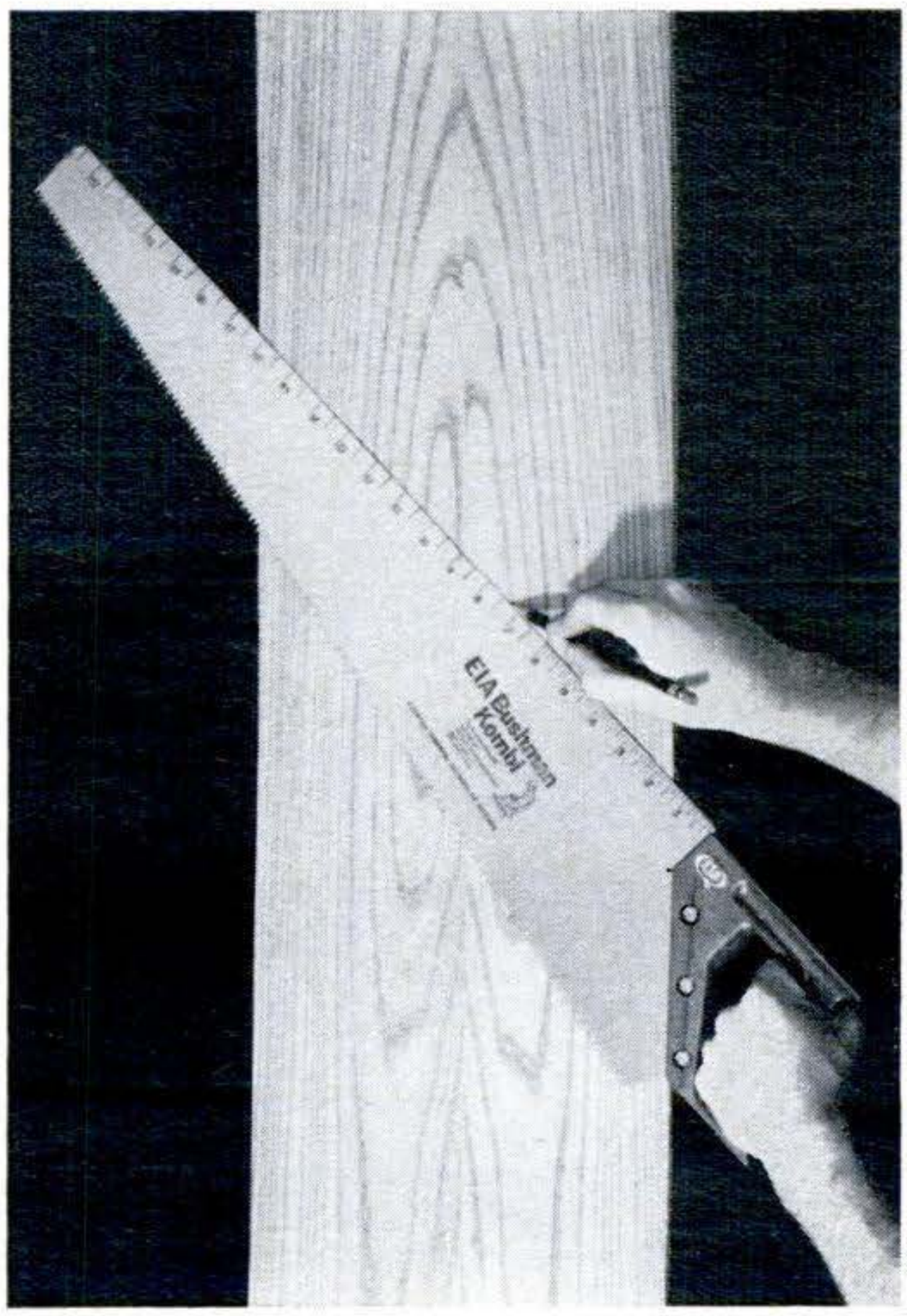
Dustless belt sander—a recent addition to Black & Decker's portable tool line—is called the U-144-1 3"-by-24" LCG. The last initials are for low center of gravity, since the 5/8-hp. motor is tucked between the pulleys to avoid a top-heavy housing that can cause rocking and gouging. The zippered collector bag keeps the area surrounding the 14-sq.-in. sanding surface free of sawdust. Price $49.99.



Insert the plug—two- or three-prong—into the Lock-A-Plug and you prevent unauthorized use of a power tool or appliance. Setting three dials to the right combination frees the plug. Looping the cord through a slot on the lock keeps the unit with the tool; wrapping the cord around a fixed object (such as a pipe) deters theft. $2.50 each from Efston Mfg. Co., 400 Prairie Ave., Wilmette, Ill. 60091.



Four tools are combined into one package in the Kombi handsaw. A measuring rule is printed the entire length of the blade. The handle is shaped to give 45- and 90-degree angles and contains levels for horizontal and vertical readings. The hardened Swedish-steel blade comes in three lengths— 22, 24, and 26 inches—available with six-, seven-, eight-, and 10-point crosscut toothing. $9.50 from Swedish Bushman, Inc., 22 W. Pennsylvania Ave., Baltimore, Md. 21204.



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A Better Tripod Than You Can Buy

[*Continued from page 161*]

a .002-.006″ adhesive clearance. Slip the extension-post knob over the ½″-diameter lock shaft and pin it in place. The pin should not protrude from either end. With the inside lock cam in place on the extension center post, drill through for pinning.

To insure free rotation of the lock shaft, use two short rollpins that won't project into the ½″ hole or outer surfaces.

Slide the shaft-and-knob assembly into the extension post so that the knob end rotates freely within the collar section and the lock shaft protrudes. Place a second lock cam over the shaft and, after taking up end play, drill through for a rollpin. Finally, slide the extension-post assembly into the center post and check for smooth, positive locking when the extension center-post knob is turned to the lock position.

The boom. After cutting the boom to size and sanding, cut the slot by drilling 15/64″ holes in a center line. Saw and file out the excess to form a slot slightly over ¼″ wide. A single-cut vixen file speeds up this step.

Face off the boom sleeve and clamp the short section of the boom arm in position. Drill, countersink, and tap for the three retaining screws. Chuck this assembly in a four-jaw chuck and bore through sleeve-and-boom section to a smooth, sliding fit over the center post.

Clamp the hinge sections of the boom arm together in a vise, using a flat backup plate to keep them in line. Drill through for a rollpin (which will insure a tight shakefree joint without precision machining).

Taking care to keep the ⅛″ gap shown, round off the tongue and yoke sections to permit bending the boom arm. Knobs can be made from drilled blanks, as shown, or knurled and machined from bar stock. The latter is faster but the first gives you a better-looking knob.

Finishing the tripod. For a handsome satin finish that won't show scratches or fingerprints easily, work over each part with a fine rotary wire brush before assembly. Chuck the brush in a drill press and, to save your eyes, be sure to wear safety goggles.

Follow the brushing with a fine steel-

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wool pad stroked in the long direction of the workpiece. Wipe clean with alcohol and a clean rag and finish with a light spray coat of an antisticking compound such as TFE (Teflon, packaged in an aerosol can). Spray all parts, including bores and threads, and finish by hand-buffing the pieces lightly with a clean, soft rag.

Final assembly. Press rubber furniture tips or crutch tips onto the leg ends. Place the legs in position on the spider, slip the leg pivots through spider and legs, and drill and pin. Insert the preload screw and tighten down enough so that a little effort is needed to change the leg angle. (Done this way, you need to use the leg locks only for extreme angles.) Insert the leg locks, using one or more washers as needed to line up the locks similarly; all should point down when they are locked.

Set the tripod on a smooth, level surface and adjust the legs so that they are 34″ apart with the center post perpendicular to the horizontal plane. Tighten the leg locks and spot-drill through the leg-stop holes approximately 1/16″ deep into the leg plug. This provides the standard lock detent, so you can level the tripod for most uses with few adjustments. Next tap the leg-lock holes 1/4″-20.

Round off the threaded ends of the knurled thumb screws and sand to such length that, when fully inserted, they prevent the leg angle from changing under pressure. When you want to change, simply back off the screw a bit.

Slip the center post into place and lock it with the center-post knob. After sliding on the boom arm, slip in the extension center post and lock it with the top knob. Attach a heavy-duty tilt-top (such as Leitz or Edmund), or pan head, to the boom with the 1/4″-20 screw and knob, and you're all ready to start loading your camera.

One final tip: I've found that hanging my gadget bag on the tripod next to the center post is a smart trick. Besides keeping equipment at hand, its extra weight gives the tripod even greater stability when a heavy camera is sitting far out on the boom. PS

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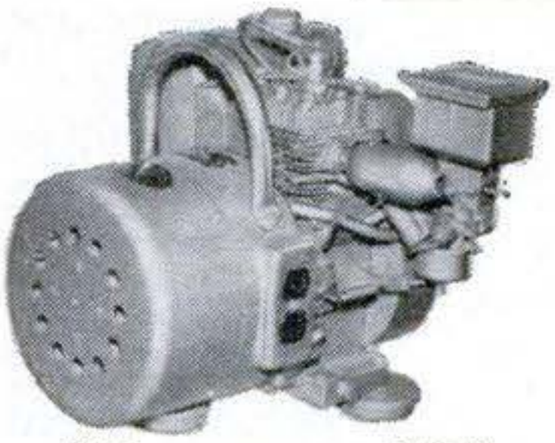

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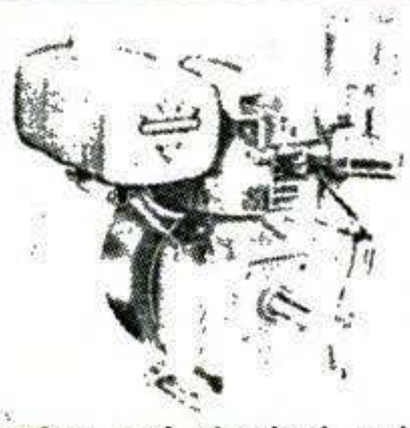

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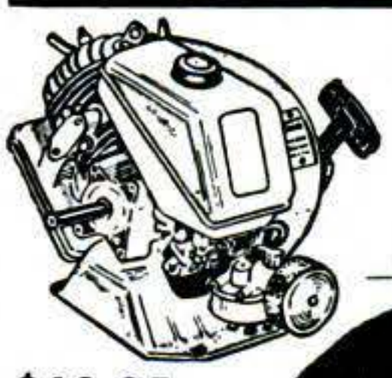

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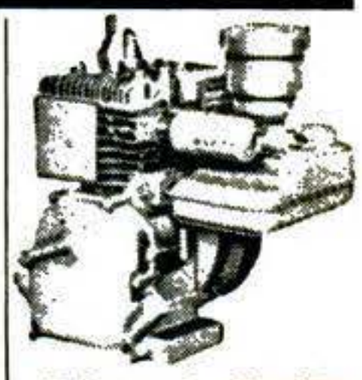

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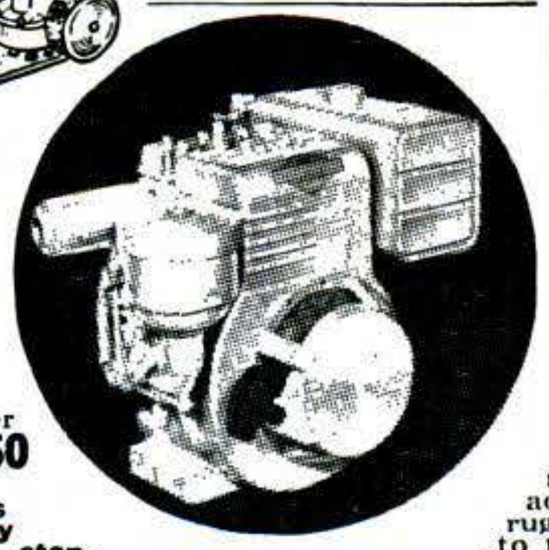

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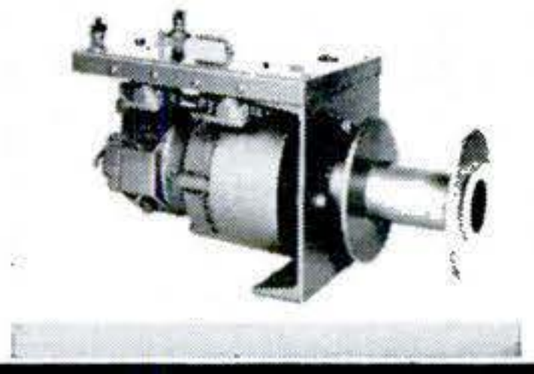

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"50 bucks until payday, please?"

One of those money machines reported in use abroad has made an appearance in Florida. The holder of a credit card from the Capital National Bank, Miami, can insert his card and instantly borrow $50 from the machine in the lobby.

Flying platform tied to truck

This whirlybird skyhook, made by Dornier of Germany, carries 120 pounds of TV, radio, or photographic gear to an altitude of 1,000 feet. A small gas turbine on board compresses air for the rotor-tip jets. The truck pumps fuel through the tethering hose and regulates altitude with a powered reel-winding drum.

Composites . . . Stronger Than Steel

[Continued from page 100]

may look like a ball of cotton or wool. Silicon carbide whiskers have lately become available by the ton, and some others by the pound.

But putting the whiskers into materials is something else again. Only now are solutions to some of the many problems beginning to appear.

You would like a composite material to contain a sizable proportion of whiskers —but they are contrary things to work with. Oriented at random like broomsticks in disarray, they may make up less than a fifth of the volume they fill. Try to pack the crystals closer by brute force, and they break. The alternative is to try to coax them into orderly alignment, side by side. One possible way is to spin whisker "wool" into a yarn, to be woven into a mat.

How to make "whisker yarn" was recently demonstrated on a miniature scale in a study for NASA at General Technologies Corp., Reston, Va. A motor turned a wire bearing a drop of adhesive at one end. By touching a wad of silicon carbide whiskers to the adhesive and drawing it along the wire, a whisker yarn was spun. The method, reported the researchers, could be scaled up for mass output by using textile-type machinery.

Grown-in whiskers. One short cut to whisker materials has been found. By casting an alloy in a mold, and withdrawing heat in one direction, researchers at United Aircraft Research Laboratories have succeeded in growing reinforcing whiskers right inside some metals. In others, the process has produced reinforcing platelets, or "lamellae," almost as good as whiskers. The scheme works with only a limited number of alloys—but among these are heat-resisting ones, from which experimental turbine blades for jet engines have already been made.

What comes next will be exciting to watch. In all the millennia since the Bronze Age, the strength-to-weight ratio of structural materials has been little more than doubled; suddenly, the new composites make it look possible to triple the ratio. And they come at a time when, to meet space objectives, the properties of conventional materials have been taxed to the practical limit. PS

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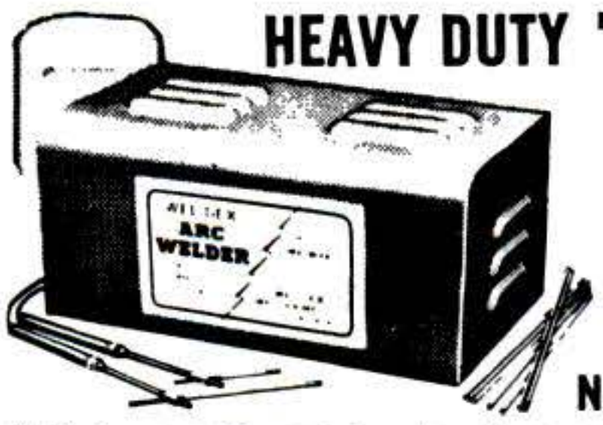

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[Continued from page 80]

are asking, "Why not man as well?" Slum children are usually smaller than those brought up on farms. But much more study is needed to determine the effect of light on growth.

What about reproduction? Poultry growers increase egg production in winter by using artificial lights. Pink fluorescent light tends to make the eggs infertile; daylight-white fluorescents make them normally fertile.

In an article in *Vision Research*, Dr. T. Shipley of the University of Miami (Fla.) School of Medicine says: "The relation of light to sexual cycles throughout the animal kingdom is one of the clearest facts of animal ecology . . . Such relationships have been found for 11 species of mammals, 21 of fowl, three of reptile, three of amphibian, and two of fish. This relationship is undoubtedly true for man as well."

In birds and most animals, light entering the eyes apparently stimulates the hypothalamus gland, which in turn stimulates reproductive glands and probably others.

There may be more to it than that. Until recently, little has been known about the pineal gland, a small body located above the third ventricle of the brain and connected to the mid-brain.

We know that the pineal is connected by nerves to the eye. It now seems more than hypothesis that light is passed through the eye to the pineal, which then influences sexual glands. Researchers at the National Institutes of Health support the view that the pineal is triggered by light accepted by the eye.

The high reproduction rate of humans in tropical countries, says Dr. Ott, could be due to exposure to natural sunlight.

The nature of the light seems to have an effect on sex determination of offspring—at least in animals. Chinchilla growers have found that under bluish light almost all offspring are female. Litters produced by animals under pink light are predominantly male.

On living longer. Dr. Ott reported to the 1968 International Photobiology Conference that breeding experiments with white rats showed that animals kept under cool white fluorescents at 1,000 footcandles had only half as many litters, with a considerably lower rate of survival of the young, as animals kept under newly developed full-spectrum fluorescent tubes.

Mice are not men, of course. But man developed in tropical areas of strong sunlight, and it could be that his life span is increased when he is exposed to reasonable amounts of natural light. In a paper published by the Building Research Institute, Dr. J. D. Hardy says the penalty for shutting out even a small degree of natural light may be acceleration of the aging process.

Danger in ultraviolet? Can ultraviolet light be dangerous—even cancer-provoking? Fear of this, Dr. Ott believes, is due to a lack of understanding of the nature of the ultraviolet light we receive. In natural sunlight, at the surface of the earth, there is a difference in relative intensities of longer-wavelength UV and shorter-wavelength UV. The atmosphere filters out or stops all of the shorter-wavelength UV except for a trace amount, but does allow the longer-wavelength UV to pass through in amounts comparable to the intensity of visible light.

The longer-wavelength ultraviolet in normal sunlight appears to be beneficial. The shorter-wavelength UV appears to be harmful.

Practically all sun lamps, Dr. Ott says, give off peak energy in the shorter-wavelength ultraviolet, and can produce severe burning and injury. Under this type of light, skin cancer has been produced in laboratory animals.

Is there any way for modern man to avoid mental and physical illness due to lack of natural light? One answer may be indoor full-spectrum lighting. Several companies are manufacturing full-spectrum fluorescent tubes—Dr. Ott, in fact, helped develop one, the Vita-Lite, being made by the Duro-Test Corp.

Do the tubes work? Obrig Laboratories, a Sarasota producer of contact lenses, installed them and reports that its employees are happier and suffer less fatigue and eyestrain. Production has increased by at least 25 percent.

There may yet be hope for humans who live, like goldfish, behind glass. PS

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The New Look in House Siding

[Continued from page 158]

What about re-siding? For many home owners, the problem is what to do about existing siding that has outlived its time. A standard answer is aluminum siding (and, to a growing extent, galvanized steel) applied over the existing material.

There are also other ideas worth thinking about. Any of the sheet-form sidings—plywood, hardboard, asbestos board - can be nailed over beat-up exterior walls. All you have to do is fir out the trim around doors, windows, corner boards.

What are the cost factors? This depends more on how hard it is to put up the siding than on the form it takes. The least expensive material in most markets is probably bevel siding, which runs as little as 27 cents a board foot, in the six-inch width, up to about 34 cents for 10-inch stuff. (Actually, ⅛-inch asbestos board comes a little cheaper, at about 20 cents a square foot, if circumstances permit its use.) At the upper end of the scale are plywood sidings at perhaps 36 cents and hardboard at about 32 cents. As you can see, the range is not great.

However, it is the time needed to put new siding on your house that should give you concern. In this respect, there is a basic truth:

It costs less to nail up a sheet of material or a wide strip than it does to nail up a dozen or more narrow strips, whether they are wood or plastic or aluminum or galvanized or hardboard or asbestos board. The cost of installation depends, too, on the care needed for the job; some materials have to be nailed just so, to avoid splitting and cracking. Others can be hammered on in a pretty relaxed manner by a man no handier, perhaps, than you, if you want to tackle the job.

A building-supplies dealer I know who was an excellent residential builder before he opened a lumberyard told me: "Probably the least expensive re-siding job you can do is plywood or hardboard siding nailed over the old boards, whether you hire it done or do it yourself."

In new construction, there is another cost-saving factor: Where building codes permit, plywood siding often provides all the construction quality required without any sheathing at all. PS

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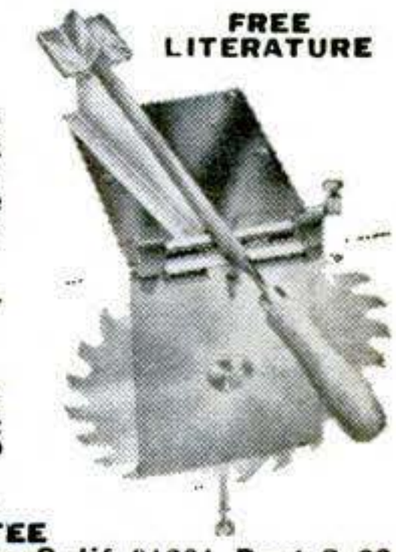

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[*Continued from page 85*]

graceful and round. Most loops are egg-shaped or half-moons.

We went into a dive to gain speed and then started climbing. Big Ed shoved home the throttle for full power. I felt myself settle into my seat, and I was saying a long-drawn-out "Ooofff." The pressure increased and pushed me squatty. I glimpsed my reflection in the glass gauge faces. I looked like the famous Air Force photo of Colonel Stapp as he slammed to a stop on that high-*g* test sled, cheeks and mouth sagging.

We neared the top of the loop. Something long and black flew up in front of me. A flat object followed. I tilted my head back and saw my pen and notebook resting quietly on the canopy. Beyond was the ground—far beyond.

Out on the horizon, the wingtip was a pivot point, the ground turning around it. I tightened my grasp on the struts. The ground slowly moved ahead, out of sight, and was replaced by sky again. My pen and tablet, meanwhile, disappeared in Mahler's direction. Then we bumped as we passed through our own wake at the bottom of the loop. My pilot turned around and caught me with a nitwit grin.

We leveled off, then tilted forward into another dive, the plane's roar changing into a whine as we gained speed for another maneuver. I squashed into the seat again and thought we were trying another loop. But instead of turning on our heads, we continued zizzing nearly straight up, flat on our backs at 4,000 feet.

Strictly for experts. Though I didn't know it at the time, we were in the maneuver known as a hammerhead stall—a nearly vertical climb with a stall at the top. Here the plane turns sideways, pivoting on a wingtip, to head earthward again in a dive. It's a dramatic maneuver, and it takes skill in timing. Says Duane Cole in his aerobatic text, *Roll Around a Point*: "If the rudder is used too late, the airplane will back up in a tail slide, then break forward violently in a whip stall. Neither is conducive to long life of the airplane."

Fortunately, Big Ed's timing is excellent. At the top of the nearly eternal climb, things suddenly got relatively quiet. The motor continued to roar, but the sound of the air whizzing down the plane's body stopped for a second. Then we pitched abruptly to the left. I found myself looking past Big Ed's head as we screamed earthward. Suddenly we leveled. Before I collected my wits, we zipped into another hammerhead.

G's and gray-outs. The transition from one hammerhead to another shoved me down again. Little black specks began flitting about the cockpit. Then I felt relaxed-saggy, and my sight slowly began diminishing, as though something was increasing my eyes' *f*-stop numbers. It was the gray-out. High *g*'s were forcing blood from my head.

I wasn't handling the plane's controls, so it didn't make any difference if I grayed out. But acrobatic fliers constantly must watch out. When they feel a gray-out coming on, they immediately loosen up the maneuver—both to bring back their sight, and to guard against the plane's coming apart. A general rule with planes built for acrobatics is that if you don't overload yourself, you won't overload your plane.

Gray-out usually happens in inside maneuvers and dive recoveries when centrifugal force pushes a pilot into his seat. *Negative g*'s happen during *outside* loops, in which a pilot tends to whip forward or up. They send blood to the head and may cause a tight feeling in the crown, or pressure in the eyes.

(Later I checked our maximum-and-minimum-*g*-force gauge in the front cockpit. During my half-hour flight we were subjected to six positive *g*'s and one negative *g*. For comparison, a roller-coaster ride may give an increase of one *g*. And my respect for our six *g*'s rose when I later learned that an average of four *g*'s is all that astronauts take when they whiz back from the moon into our atmosphere at nearly 25,000 m.p.h.!)

Suddenly I noticed that instead of doing more stunts we were heading back to the airport. And I was sorry. Flipping around the sky, I was surprised to discover, is fantastic sport. I had expected to be sick, scared, dizzy. I was none of these—simply thoroughly exhilarated. One of these days *I'm* going to learn to stunt through the sky. PS

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New Twist in Portable Jigsaws

[Continued from page 197]

the saw chatters, use a faster speed—but it is preferable to use a finer blade.

- Slower speeds for thicker metals.
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The Thor offers no speed choice. It delivers a no-load 3,400 strokes a minute.

The saws in action. The Sears saw is big—nearly nine inches in both length and height (compared with the 7¾-inch dimensions of the Thor). It's part of Sears' beefed-up Craftsman commercial line, aimed at heavy-duty professional use as well as the home shop. The motor develops ½ hp. So the tool has big-saw features. The blade fastens in with two screws, one to line it up laterally, the other to seat it firmly against a backstop. The stroke is a full inch. It doesn't slow down coming through a four-by-four—unless you force it.

The smaller Thor boasts a two-inch-depth capacity in wood, ⅛ inch in steel, and a ⅝-inch stroke. Yet the Sears saw can cut the same small-saw capers. Both handle much the same. Using the rotating head, you move the saw forward with one hand and do your fine steering with the other. In turns of only 30 degrees or so, the saw follows the turn of the spindle. When you go beyond that, the hand that pushes must exert pressure to the side, to drive the blade along the desired path. This comes almost automatically, and after a few inches of cutting you find yourself coordinating the two motions with no trouble.

The idea quickly passes that you always hold the body of the saw at one angle, turning only the head. You soon find that a combination of knob turning, saw-body turning, and lateral pressures does the job with the most ease.

There's a difference in price between the saws, of course, to reflect the difference in size and features. The Sears saw is just under $60, the Thor about $45. Sears offers a $6 carrying case and a table for $7.99. Blade-position accessories are priced in the photo captions. Where no price is given, item is included in purchase price. Only the Sears saw was available for photography before we went to press with this article. PS

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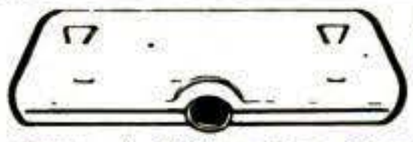

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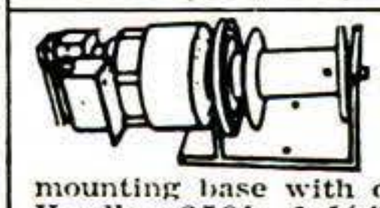

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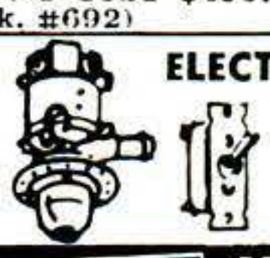

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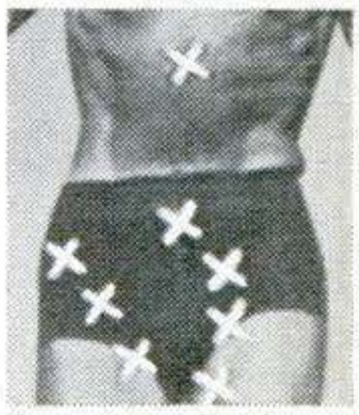

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